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LONG RANGE SEISMIC MEASUREMENTS

BOURBON

20 JANUARY 1967

Prepared for

AIR FORCE TECHNICAL APPLICATIONS CENTER

Washington, D. C.

9 JUNE 1967

By

TELEDYNE INC.

Under

Project VELA UNIFORM

Sponsored By

ADVANCED RESEARCH PROJECTS AGENCY

Nuclear Test Detection Office

ARPA Order No. 624

LONG RANGE SEISMIC MEASUREMENTS

BOURBON

20 January 1967

SEISMIC DATA LABORATORY REPORT 186

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Project Title:	Seismic Data Laboratory
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P. O. Box 334, Alexandria, Virginia

AVAILABILITY

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BOURBON

EVENT DESCRIPTION

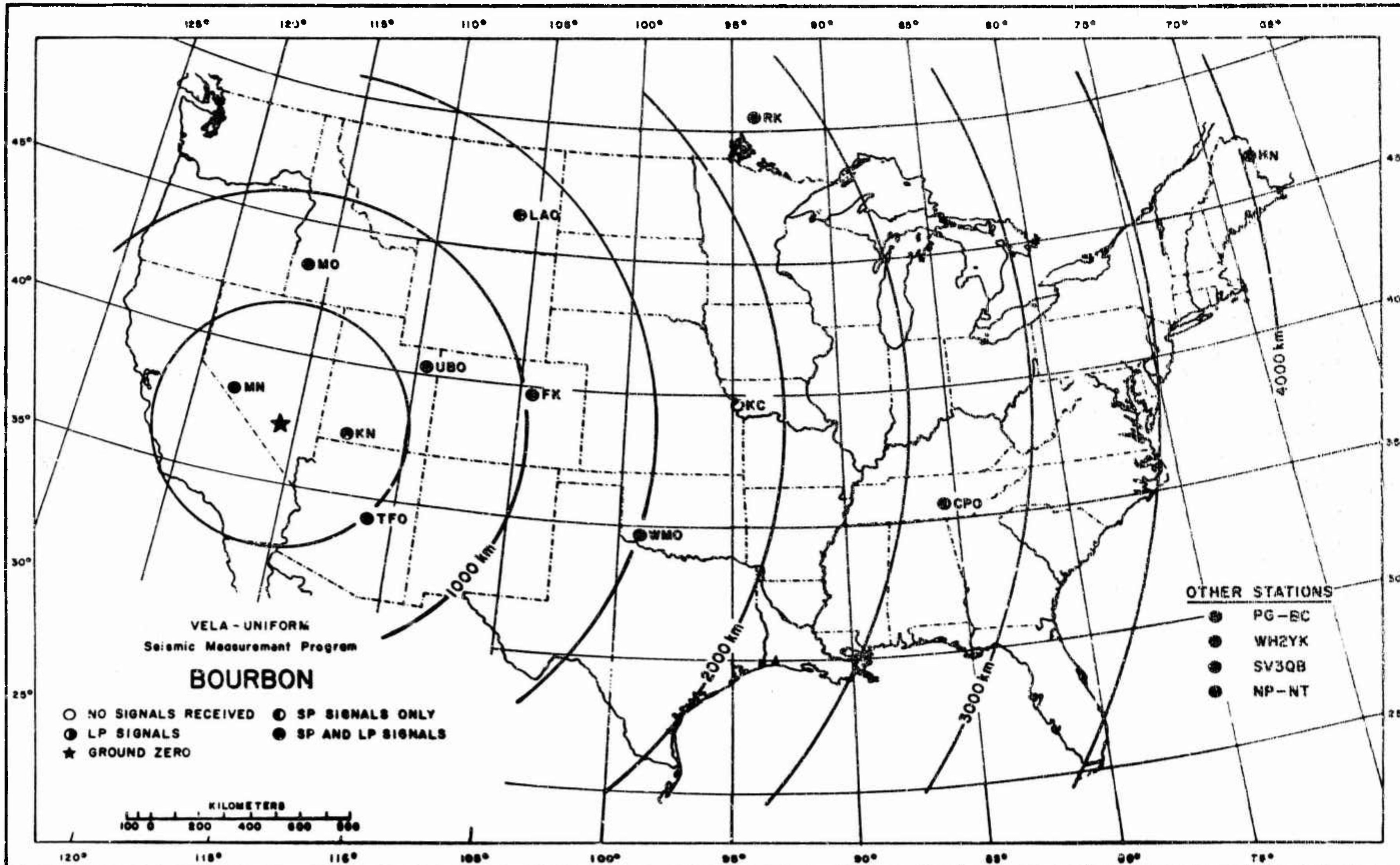
DATE:	20 January 1967	
TIME OF ORIGIN:	17:40:04.4	
YIELD:		
MAGNITUDE:	5.09 ± 0.61	
LOCATION:		
SITE:	Nevada Test Site, Area U7n	
	GEOGRAPHIC COORDINATES:	
	Lat:	37°05'59.0" N
	Long:	116°00'14.0" W
ENVIRONMENT:		
	GEOLOGIC MEDIUM:	TUFF
	SURFACE ELEVATION:	4375 ft.
	SHOT ELEVATION:	2526 ft.
	SHOT DEPTH:	1849 ft.
COMPUTED EPICENTER:	ALL STATIONS	
	GEOGRAPHIC COORDINATES:	
	Lat:	36°58'48.0" N
	Long:	116°04'58.8" W
	TIME OR ORIGIN:	17:40:03.6Z
	DEPTH CONSTRAINED TO:	0 km
	EPICENTER SHIFT:	15.0 km, S 28° W

Code	Station	Final							
		SPZ	SPR	SPT	LPZ	LPR	LPT	Tape	Timing
MN-NV	Mina, Nevada	+	+	+	+	+	+	*	P
KN-UT	Kanab, Utah	+	+	+	+	+	+	*	P
TFSO	Tonto Forest Seismological Observatory, Arizona	+	+	+	+	+	+	*	P
MO-ID	Mountain Home, Idaho	+	+	+	+	+	+	*	P
UBSO	Uinta Basin Seismological Observatory, Utah	+	+	+	+	+	+	*	P
FK-CO	Franktown, Colorado	+	+	+	+	+	+	*	P
LAO	Subarray AO-10 Montana	+	N	N	+	-	-		P
WMSO	Wichita Mountain Seismological Observatory, Oklahoma	+	+	+	+	-	+	*	P
KC-MO	Kansas City, Missouri	S T A T I O N M O V I N G							
PG-BC	Prince George, British Columbia, Canada	+	+	+	+	+	-	*	P
RK-ON	Red Lake, Ontario,Canada	+	+	+	+	+	+	*	P
CPSO	Cumberland Plateau Seismological Observatory, Tennessee	+	+	+	+	+	+	*	P
WH2YK	Whitehorse, Yukon Territory, Canada	+	+	-	+	+	+	*	P
HN-ME	Houlton, Maine	+	+	+	+	+	-	*	P
SV3QB	Schefferville,Quebec,Canada	+	+	-	+	-	-	*	P
NP-NT	Mould Bay, Northwest Territories, Canada	+	+	+	+	-	-	*	P

N No Instrument + Signal
P Primary Timing - No Signal

STATION STATUS REPORT - BOURBON

TABLE 1



Recording Stations and Signals Received

Figure 1

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INTRODUCTION

A long range seismic measurements (LRSM) program and several larger seismographic observatories were established under VELA-UNIFORM to record seismological data resulting from natural seismic activity and a planned series of U. S. underground nuclear tests. The LRSM teams are mobile and occupy locations selected to provide optimum data from events of special interest; the observatories are permanent installations as follows:

Wichita Mountains Seismological Observatory (WMSO)
Lawton, Oklahoma

Cumberland Plateau Seismological Observatory (CPSO)
McMinnville, Tennessee

Uinta Basin Seismological Observatory (UBSO)
Vernal, Utah

Tonto Forest Seismological Observatory (TFSO)
Payson, Arizona

Large Aperture Seismic Array (LASA)
Billings, Montana

The purpose of this report is to provide an analysis of data resulting from the BOURBON event recorded by the LRSM teams and the VELA observatories and a preliminary summary of data reported by other permanent and temporary seismographic stations.

INSTRUMENTATION AND PROCEDURE

The instrumentation at each of the LRSM locations consists of three-component short-period and three-component long-period seismographs. In general, data are recorded on 35 millimeter film and

on one-inch 14 channel magnetic tape, although recently more portable instrumentation has been incorporated which records only on magnetic tape. The stations are all equipped to record WWV continuously to provide accurate time control. Calibration is accomplished once each day and just prior to each shot at the operational settings. Pertinent information useful for analysis of LRSM data is available to qualified users of this data and is contained in Technical Report 65-43, "Interpretation and Usage of Seismic Data, LRSM Program." General information on LRSM van and portable system equipment and operation is given in Technical Report 66-27, "The LRSM Mobile Seismological Laboratory," and 65-74, "A Portable Seismograph." Copies of these reports may be obtained from DDC. The AD control number of Technical Report 66-27 is 480343. All the observatories have both long-period and short-period, three-component instrumentation, in addition to their other specialized facilities.

Station information is presented in Appendix I(A). This includes the station name and code; the geographic coordinates; the distances and azimuths involved; the station elevations; and the type of instruments in use at each location. Representative instrumental response curves are shown in Appendix II(B), II(C), and II(D).

The procedures used in measuring amplitudes reported herein are illustrated in Appendix II(A) and the unified magnitude is calculated as shown in Appendix I(B). The distance factors (B) beyond 16° are

from Gutenberg and Richter*. For distance less than 16° values were read from a curve in the Gutenberg and Richter paper back to 10° and then extrapolated to 2°, using an inverse cube relationship. An additional magnitude for less than 16° was computed using a method described by Evernden**. (Figure 3).

A standard hypocenter location program for a digital computer is used to determine the location using data from all stations analyzed. Best-fit values of latitude, longitude, and time of origin are determined statistically by a least squares technique. This utilizes a Jeffreys-Bullen travel-time curve as modified by Herrin in 1961 on the basis of Pacific surface-focus recordings. Precision of the computation is limited primarily by the accuracy of arrival times, the validity of the standard travel-time curve, and by local velocity deviations. This method is based on P-wave arrivals with depth constrained to zero.

DATA AND RESULTS(LRSM AND VELA OBSERVATORIES)

The parameters of the BOURBON event and a summary of the seismic evaluation is shown on the Event Description page. The operational status of the 16 LRSM stations and observatories is given in Table I and illustrated in Figure 1.

* Gutenberg,B. and Richter,C.F., Magnitude and Energy of Earthquakes, Ann. Geofis., 9 (1956), pp. 1-15.

** Evernden, J.F., Magnitude Determination at Regional and Near Regional Distances in the United States, AFTAC/VELA Seismological Center Technical Report VU-65-4A, (1965), pp. 6, 13.

Table 2 summarizes the measurements made of the principal phases from the BOURBON event at the LRSM and VELA stations. Included are the Pn and P arrival times, the maximum amplitudes (A/T) of Pn or P motion and other phases as seen on the short-period vertical instruments. Long-period Love and Rayleigh wave motion are also tabulated in (A/T) form. In addition, individual station Rayleigh wave areas (mm^2) is indicated as measured on the LPZ only. Although reduced to 1K magnification, they have not been normalized to any magnitude. Fifteen stations recorded short-period and long-period signals from this event.

The unified magnitudes determined from the LRSM and VELA observatories are shown in Figure 2. The average magnitude is 5.09 $\pm$ 0.61. The adjusted unified magnitude is 4.78 $\pm$ 0.56 and is shown in Figure 3.

The travel-time residuals from the Pn and P phases are shown in Figure 4. Figures 5 through 9 illustrate plots of the amplitude of P, Pg, Lg, LQ, and LR.

Attached to the report are illustrative seismograms showing the signals recorded at four stations. The most distant station analyzed that recorded BOURBON was NP-NT at a distance 4368 kilometers.

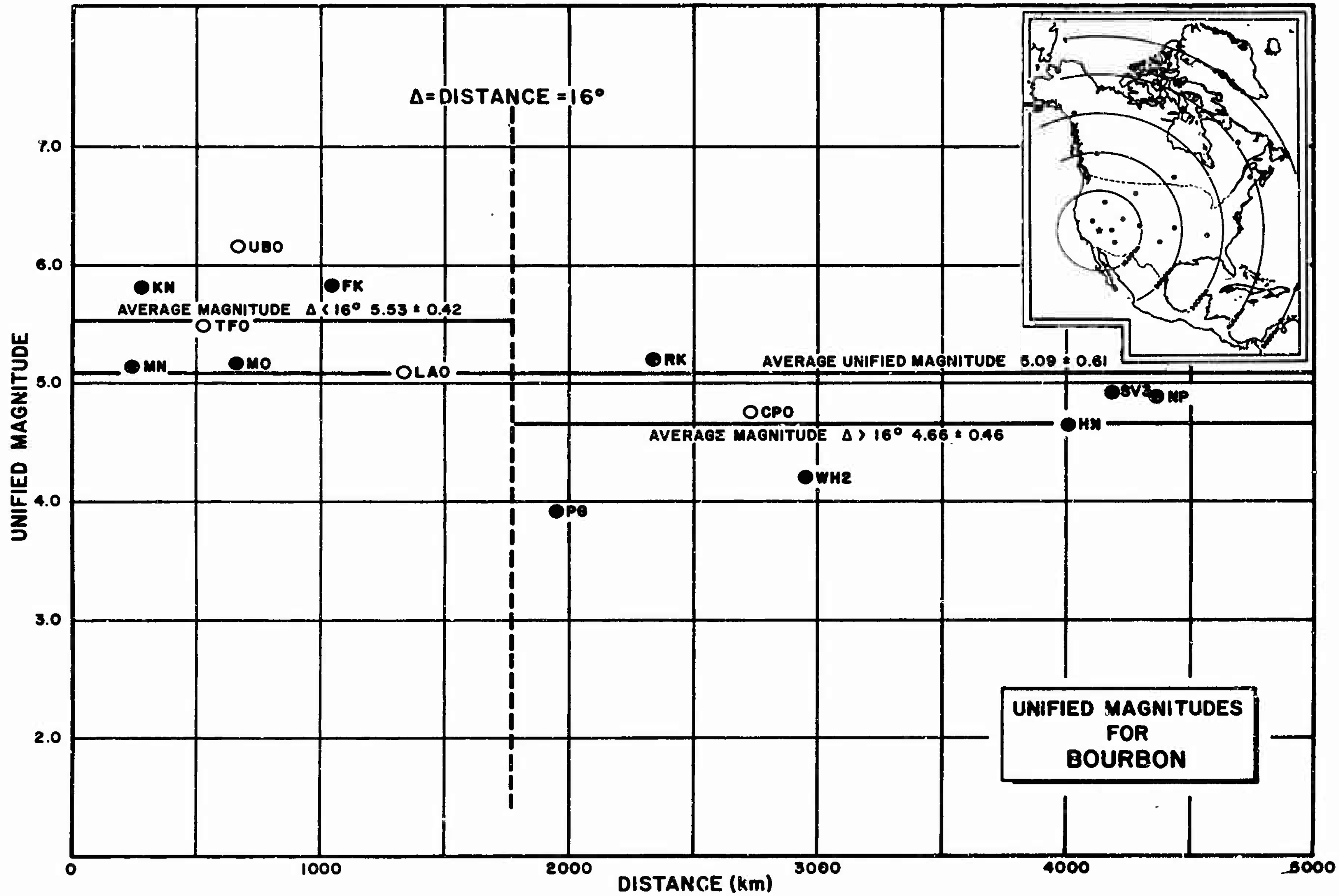
PRINCIPAL PHASES
BOURBON
20 January 1967
17:40:04.48

Code	Station	Distance (km)	Inst.	Magnification (k) Film x 10	Phase	Observed Travel Time (min)	(sec)	Period T (sec)	Maximum Amplitude A/T	Magnitude mb	Ms	Area (mm^2) LPZ
NN-NV	Mina, Nevada	240	SPZ	2.4	Pn		35.9	0.4	745	5.15	4.68	
			SPZ	2.4	a		36.9	0.25	1258			
			SPZ	2.4	Pg		38.8	0.55	4403			
			SPT	4.52	Lg			(0.8)	(5691)			
			LPT	19.42*	LQ			9.0	613			
			LPZ	3.0	LR			12.0	2751			490.00
KN-UT	Kanab, Utah	293	SPZ	4.04	Pn		41.6	0.4	2238	5.82	5.52	
			SPZ	1.59*	Pg		(45.8)	0.6	9236			
			SPT	0.71*	Lg			1.3	16732			
			LPT	23.71*	LQ			11.0	526			
			LPZ	3.38	LR			13.0	623			127.22
TFSO	Tonto Forest Seismological Observatory, Arizona	530	SPZ-60	13.8	Pn	1	13.3	0.35	146	5.49	5.07	
			SPZ-60	13.8	(P*)	1	22.8	0.45	76.0			
			SPZ-60	13.8	Pg	1	26.9	0.65	680			
			SPZ	13.1	Lg			(1.2)	(355)			
			SPZ	13.1	Lg			1.2	559			
			LPN	33	LQ			9.0	117			
			LPZ	38	LQ			9.0	116			
			LPZ	4.0	LR			15.0	347			195.38
HO-ID	Mountain Home, Idaho	664	SPZ	40.75	Pn	1	30.1	0.45	37.8	5.17	4.73	
			SPZ	40.75	a	1	32.2	0.5	(66.6)			
			SPZ	40.75	a	1	38.5	0.5	182			
			SPZ	40.75	Pg	1	47.4	(0.9)	(1094)			
			SPT	32.0	Lg			(1.1)	(2884)			
			LPT	65.6	LQ			---	---			
			LPZ	4.5	LR			12	336			63.89
UBSO	Uinta Basin Seismological Observatory, Utah	664	SPZ-10	5.3	Pn	1	32.3	0.5	369	6.16	5.93	
			SPZ-10	5.3	Pg	1	47.6	.5	901			
			SPZ	5.3	Lg			1.3	1249			
			SPE	5.3	Lg			(1.3)	(744)			
			LPN	11.5	LQ			20.0	22.2			
			LPE	12.0	LQ			20.0	9.6			
			LPZ	13.0	LR			15.0	75.4			63.85
FK-CO	Franktown, Colorado	1045	SPZ	191.7	Pn	2	(18.4)	0.7	38.5	5.83	4.36	
			SPZ	191.7	(PP)	2	25.4	0.7	21.5			
			SPZ	191.7	a	2	34.5	0.6	44.5			
			SPZ	191.7	Pg	2	53.6	(0.9)	(161)			
			SPT	129.8	Lg			(1.6)	(485)			
			LPT	18.7	LQ			15.0	131			
			LPZ	2.84	LR			11.0	727			81.31
LAO	Subarray AO-10, Montana	1337	SPZ	325	Pn	2	51.8	0.85	9.7	5.09	3.98	
			SPZ	325	a	2	53.8	0.75	25.3			
			SPZ	37.5	a	3	06.1	0.8	44.4			
			LPZ	2.16	LR			11.0	321			25.46
WMSO	Wichita Mountain Seismological Observatory, Oklahoma	1591	SPZ-6	125	P		OBSCURED BY LOCAL EVENT					
			SPZ-6	125	Pg	4	26.2	1.0	62.0			
			SPZ	125	Lg			1.5	187			
			SPZ	125	Lg			1.4	35.7			
			LPZ	48.0	LQ			20.0	19.4			
			LPZ	10.7	LR			16.0	64.5			40.65
PG-BC	Prince George, British Columbia, Canada	1945	SPZ	162	P	4	06.8	(1.0)	(10.8)	(3.39)		
			SPZ	162	a	4	09.0	1.0	22.4			
			SPZ	152	Lg			1.8	(42.6)			
			SPT	170	Lg			1.8	38.1			
			LPZ	23.0	LR			110	190			32.61

PRINCIPAL PHASE
BOURBON
20 January 1967
17:40:04.4Z

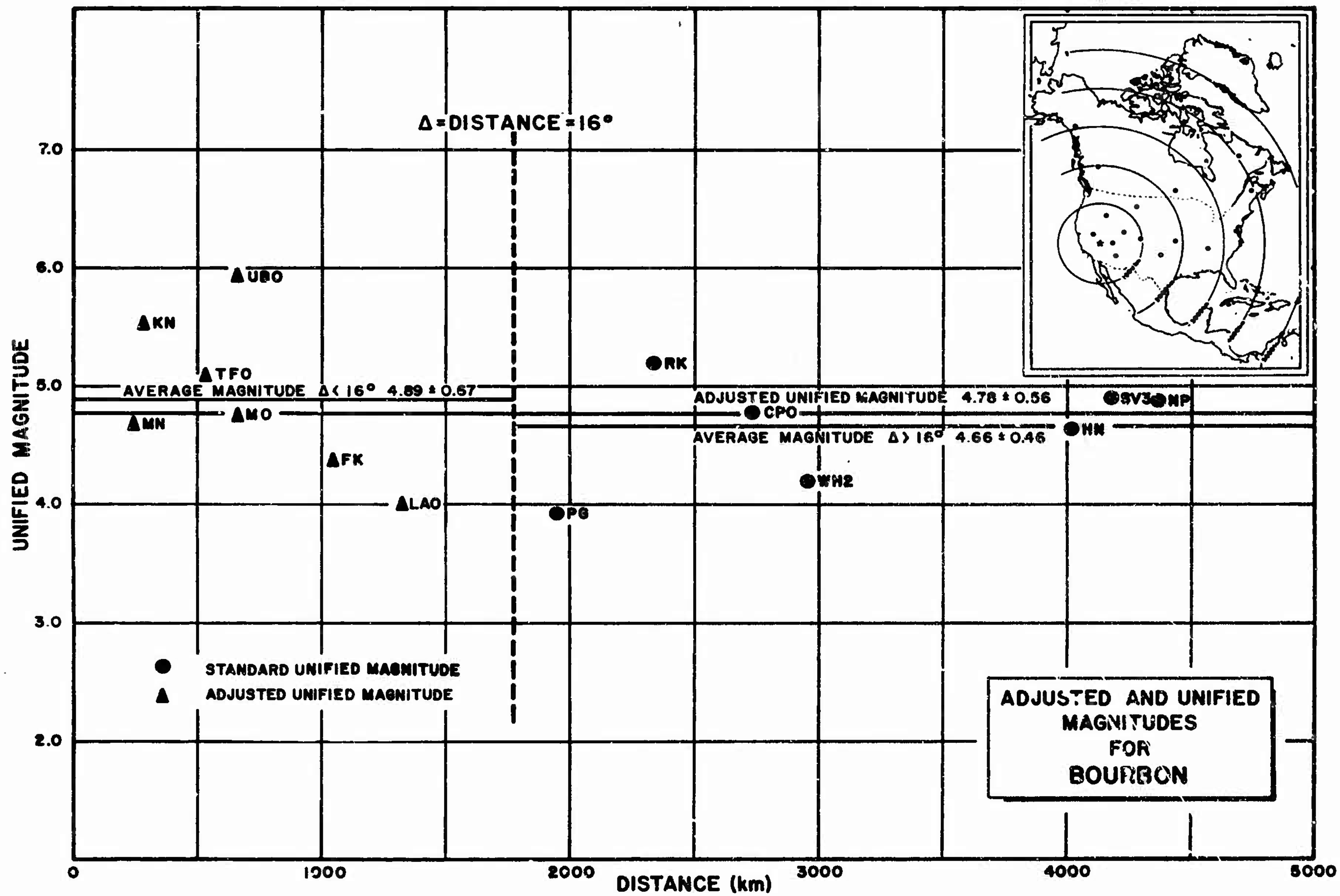
Code	Station	Distance (km)	Inst.	Magni-fication (k) Film x 10	Phase	Observed Travel Time (Min)	(Sec)	Period T (sec)	Maximum Amplitude A/T	Magni-tude mb	ms	Area (mm)^2 LPZ
RK-ON	Red Lake, Ontario, Canada	2339	SPZ	257	P	4	44.2	0.8	126	5.20		
			SPZ	257	*	4	57.7	0.8	30.7			
			SPZ	257	(PP)	5	05.8	1.1	36.4			
			SPT	249	Lg			2.2	93.0			
			LPT	54.9	(LQ)			9.0	(130)			
			LPZ	6.61	LR			(10.0	(109)			6.58
CPSO	Cumberland Plateau Seismological Observatory Tennessee	2726	SPZ-8	390	P	5	(20.3)	0.75	24.0	4.78		
			SPZ-8	390	*	5	27.3	0.9	16.4			
			SPZ-8	390	(PP)	5	44.0	1.1	16.7			
			SPN	430	Lg			1.8	50.4			
			SPE	420	Lg			(1.8)	(30.4)			
			LPN	7.5	LQ			15.0	28.0			
			LPZ	5.5	LR			16.0	85.0			69.09
WH2YK	Whitehorse, Yukon Territory, Canada	2947	SPZ	195	P	5	(19.2)	0.8	5.7	4.21		
			LPT	12.0	(LQ)			10.0	373			
			LPZ	5.4	LR			13.0	153			81.48
HN-ME	Houlton, Maine	4062	SPZ	84.7	P	7	06.5	0.8	13.0	4.66		
			SPZ	84.7	*	7	08.0	0.8	21.7			
			LPZ	31.9	LR			12.0	90.8			23.35
SV3QB	Schefferville, Quebec, Canada	4185	SPZ	125	P	7	(15.6)	(0.8)	(26.5)	(4.92)		
			SPZ	125	*	7	19.4	0.8	14.7			
			SPZ	125	*	7	22.0	0.65	9.5			
			SPZ	125	PP	8	44.0	0.7	8.2			
			SPR	116	Lg			1.0	10.8			
			LPZ	23.4	LR			(14.0	(29.0)			50.00
MP-NT	Mould Bay, Northwest Territories, Canada	4368	SPZ	240	P	7	29.9	0.8	31.0	4.89		
			SPZ	240	*	7	36.8	0.75	16.5			
			SPZ	240	(PP)	9	(00.1)	1.2	(9.4)			
			SPZ	240	(PCP)	9	37.6	0.8	7.0			
			SPT	628	Lg			2.5	28.8			
			LPZ	11.3	LR			17.0	49.1			32.30

A/T mµ/sec
( ) Doubtful values or phases
* Measurements made from playouts
--- Maximum Amplitude clipped on film & tape



Δ=DISTANCE =16°
UNIFIED MAGNITUDE
7.0
6.0
5.0
4.0
3.0
2.0
0
1000
2000
3000
4000
5000
DISTANCE (km)
UBO
KN
FK
AVERAGE MAGNITUDE Δ < 16° 5.53 ± 0.42
TFO
MN
MO
LAO
RK
AVERAGE UNIFIED MAGNITUDE 5.09 ± 0.61
CPO
AVERAGE MAGNITUDE Δ > 16° 4.66 ± 0.46
HN
WH2
PG
NP
UNIFIED MAGNITUDES
FOR
BOURBON

Figure 2



Δ=DISTANCE=16°
7.0
6.0
5.0
4.0
3.0
2.0
UNIFIED MAGNITUDE
UBO
KN
TFO
AVERAGE MAGNITUDE Δ< 16° 4.89 ± 0.67
MN
MO
FK
LAO
PG
RK
CPO
WH2
ADJUSTED UNIFIED MAGNITUDE 4.78 ± 0.56
AVERAGE MAGNITUDE Δ> 16° 4.66 ± 0.46
SV3
NP
HN
STANDARD UNIFIED MAGNITUDE
ADJUSTED UNIFIED MAGNITUDE
ADJUSTED AND UNIFIED MAGNITUDES FOR BOURBON
0
1000
2000
3000
4000
5000
DISTANCE (km)

Figure 3

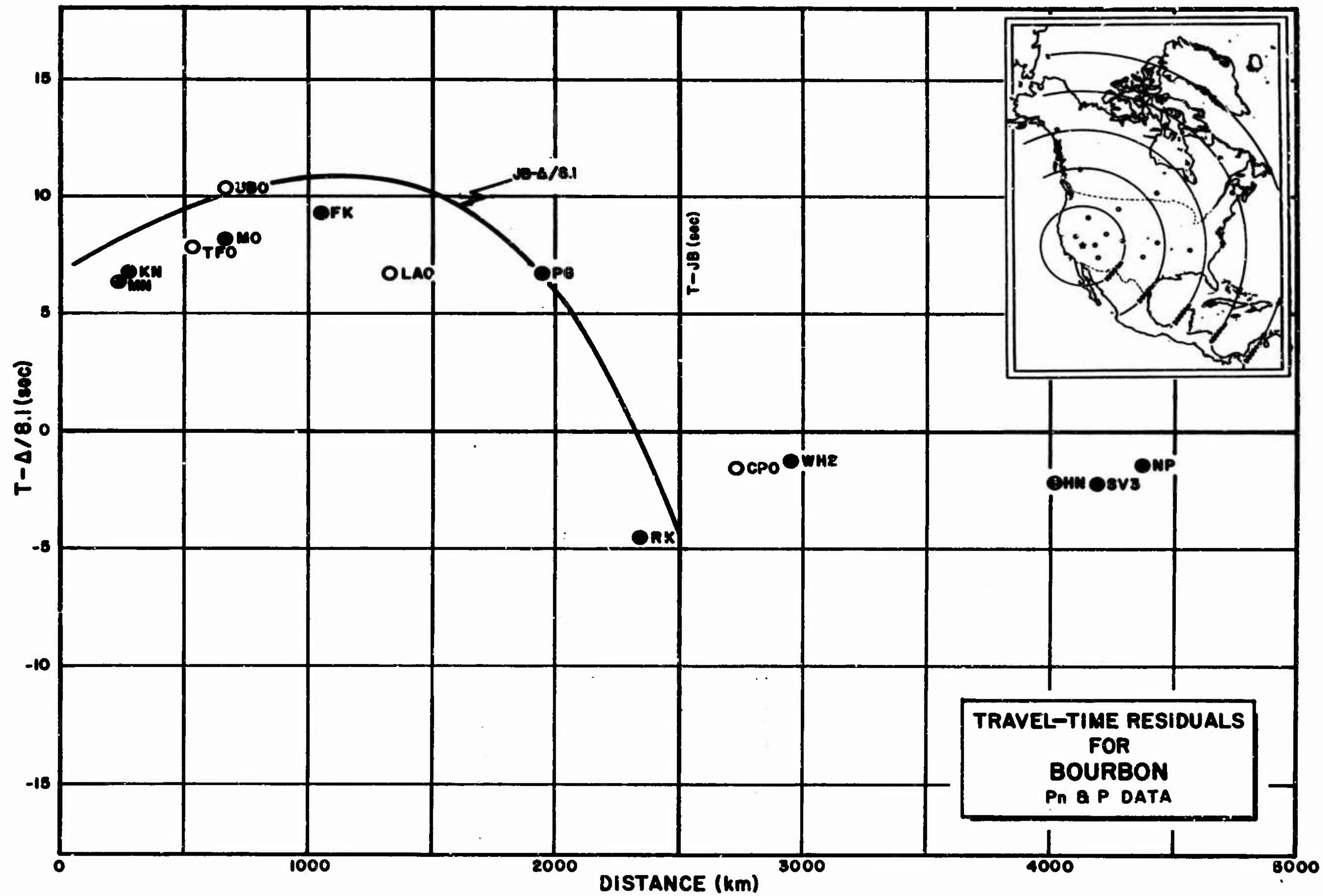
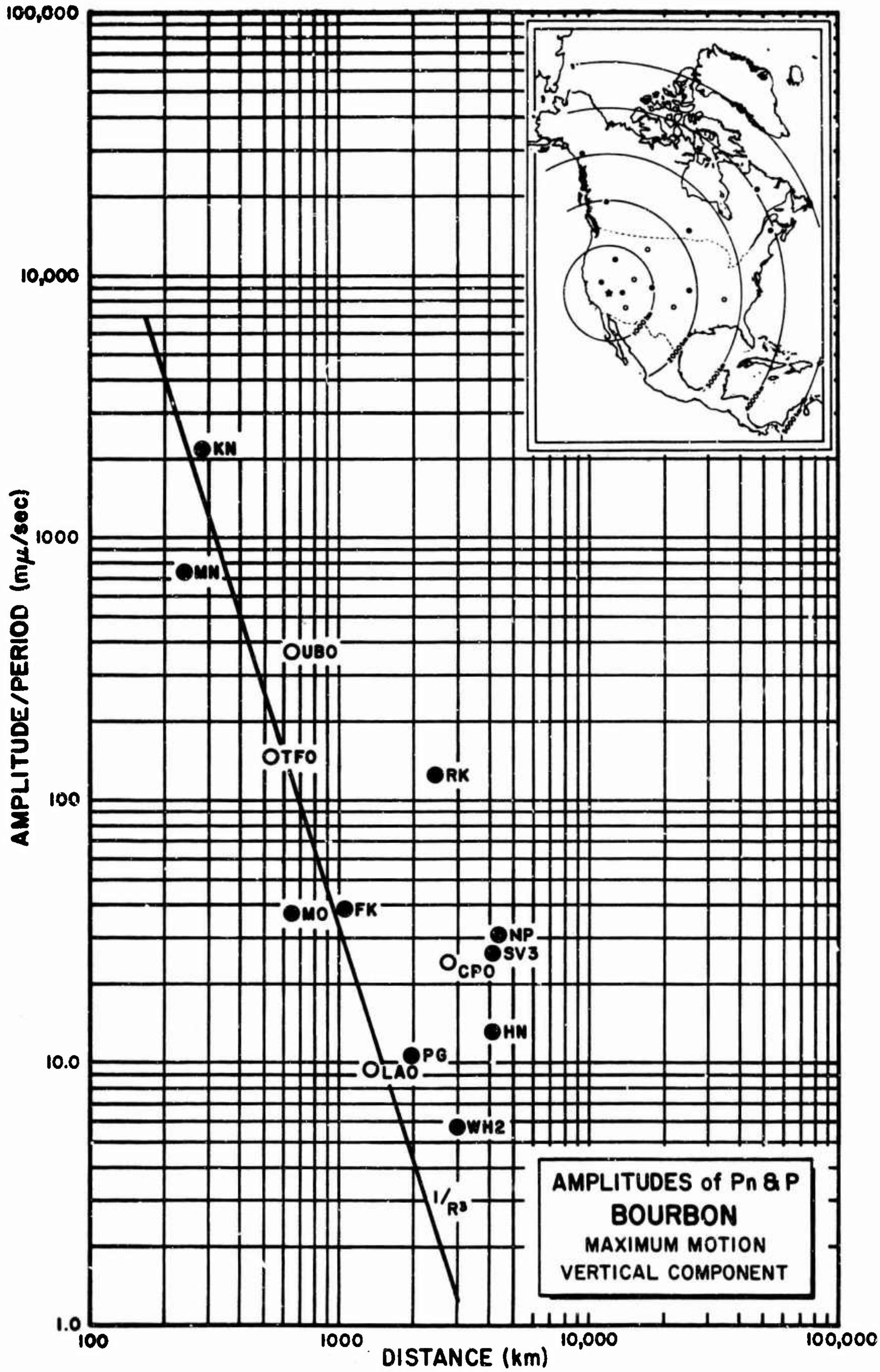
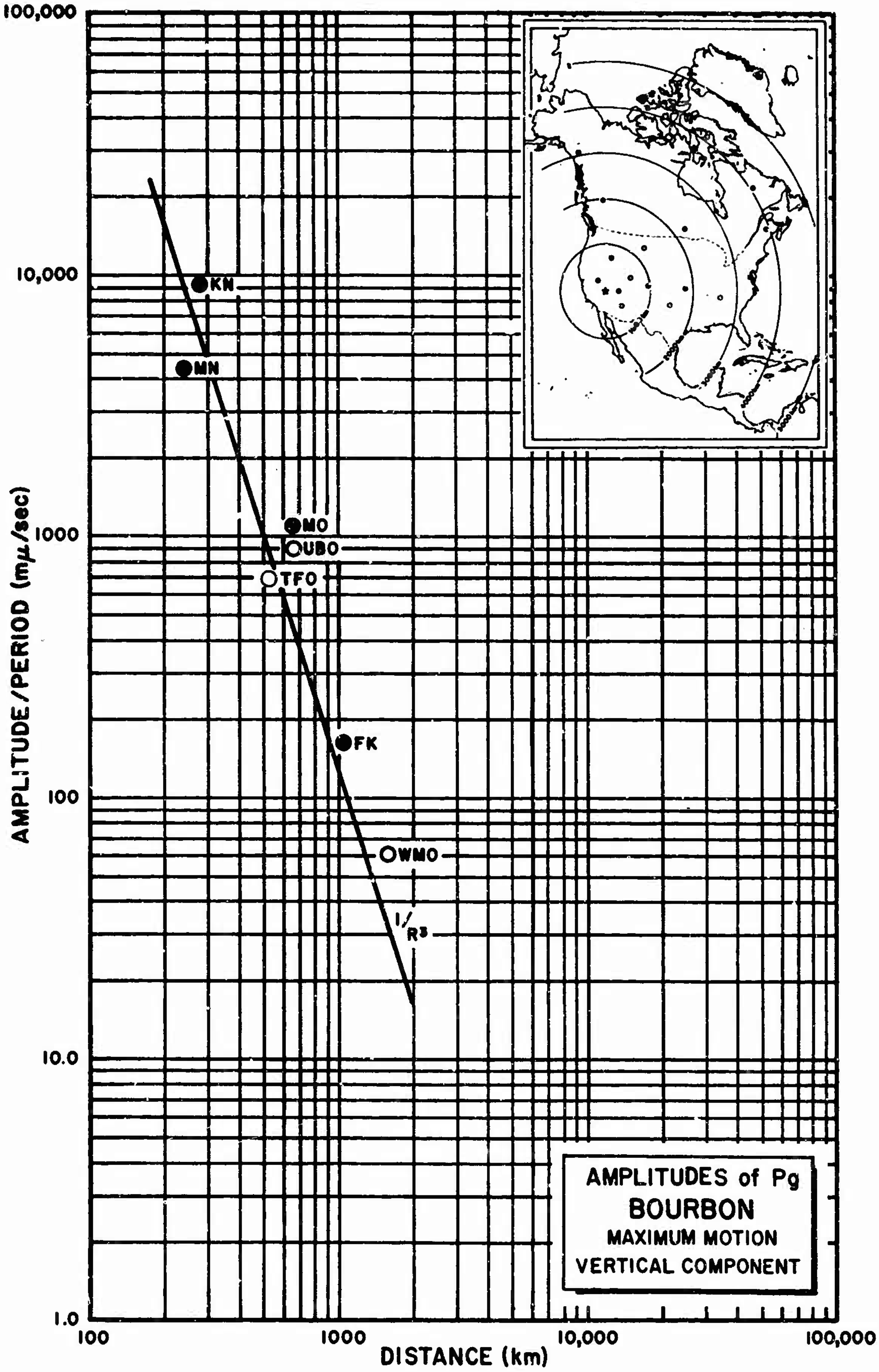

TRAVEL-TIME RESIDUALS
FOR
BOURBON
Pn & P DATA
T-Δ/8.1 (sec)
DISTANCE (km)
T-JB (sec)
JB-Δ/8.1
KN
MN
TFO
MO
UBO
FK
LAO
PG
RK
CPO
WH2
HN
SV3
NP
15
10
5
0
-5
-10
-15
0
1000
2000
3000
4000
5000

Figure 4



AMPLITUDES of Pn & P
BOURBON
MAXIMUM MOTION
VERTICAL COMPONENT
AMPLITUDE/PERIOD (mμ/sec)
DISTANCE (km)
100,000
10,000
1000
100
10.0
1.0
100
1000
10,000
100,000
KN
MN
UBO
TFO
RK
MO
FK
NP
SV3
CPO
HN
PG
LAO
WH2
1/R³

Figure 5



AMPLITUDES of Pg
BOURBON
MAXIMUM MOTION
VERTICAL COMPONENT
AMPLITUDE/PERIOD (mμ/sec)
DISTANCE (km)
100,000
10,000
1000
100
10.0
1.0
100
1000
10,000
100,000
KN
MN
MO
UBO
TFO
FK
WMO
1/R3

Figure 6

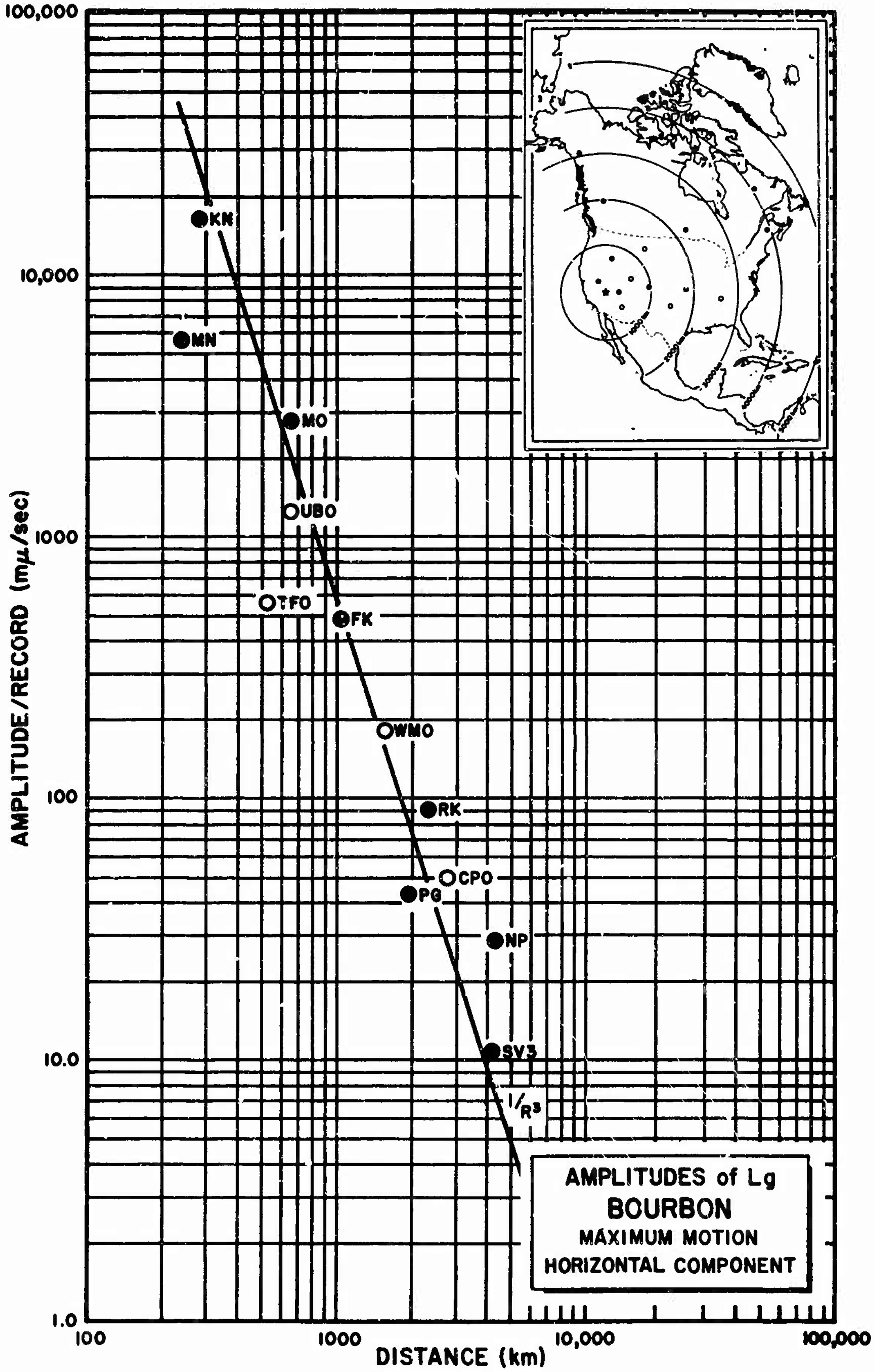
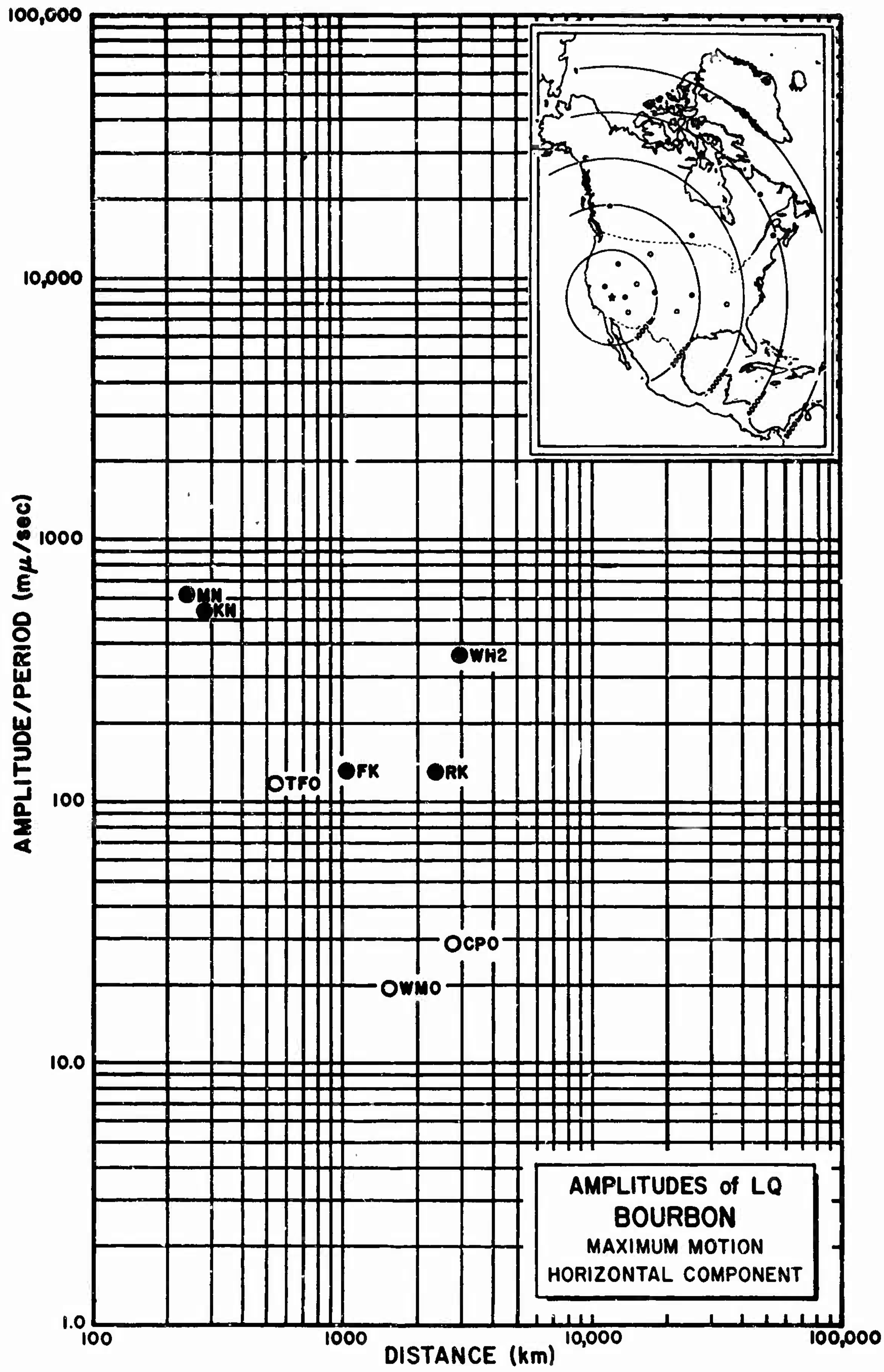
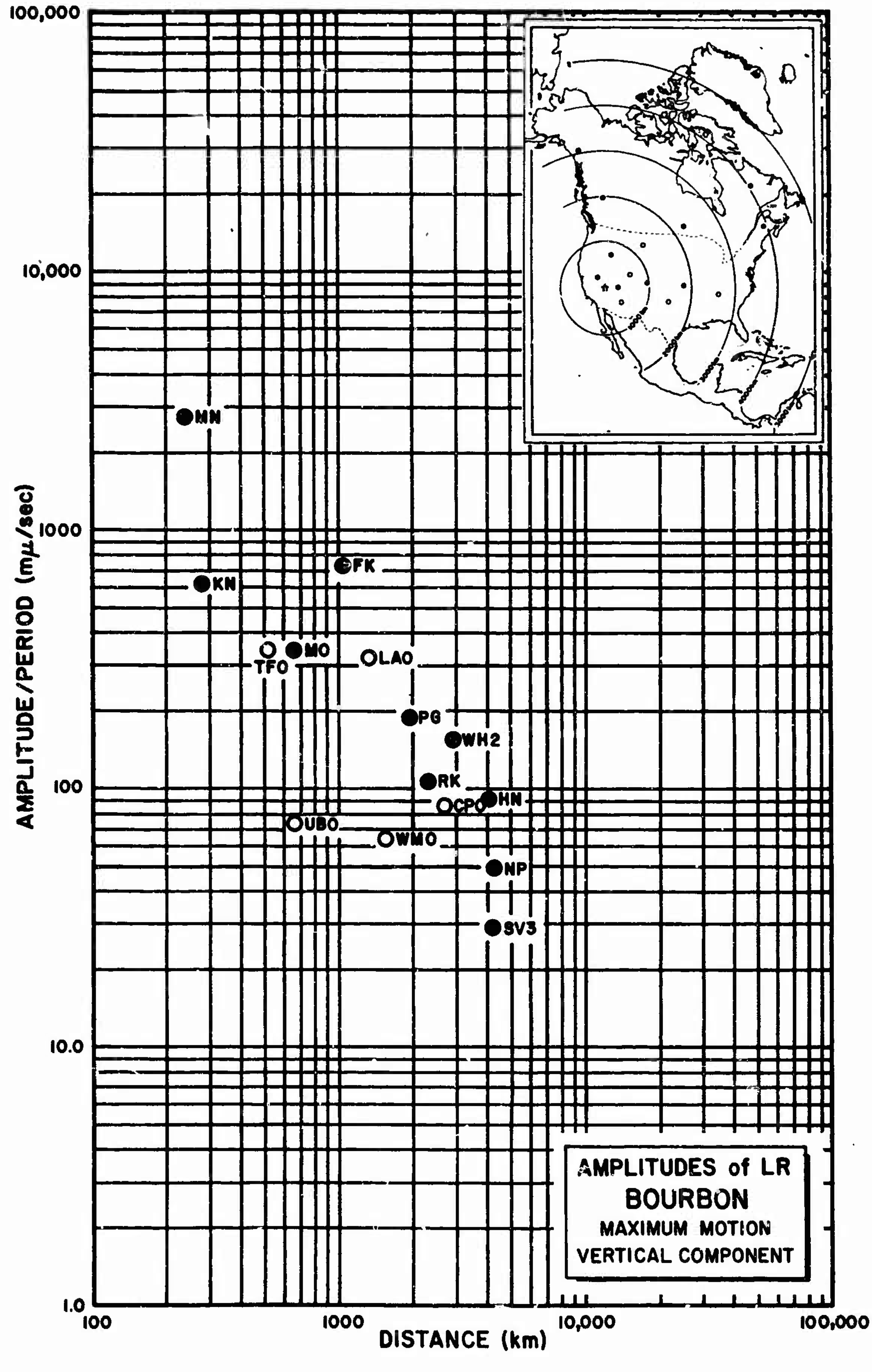

100,000
10,000
1000
100
10.0
1.0
AMPLITUDE/RECORD (mμ/sec)
100
1000
10,000
100,000
DISTANCE (km)
KN
MN
MO
UBO
TFO
FK
WMO
RK
CPO
PG
NP
SV3
1/R³
AMPLITUDES of Lg
BOURBON
MAXIMUM MOTION
HORIZONTAL COMPONENT

Figure 7



100,000
10,000
1000
100
10.0
1.0
AMPLITUDE/PERIOD (mμ/sec)
MN
KN
WH2
TFO
FK
RK
CPO
WMO
100
1000
10,000
100,000
DISTANCE (km)
AMPLITUDES of LQ
BOURBON
MAXIMUM MOTION
HORIZONTAL COMPONENT

Figure 8



AMPLITUDES of LR
BOURBON
MAXIMUM MOTION
VERTICAL COMPONENT
AMPLITUDE/PERIOD (mμ/sec)
DISTANCE (km)
100,000
10,000
1000
100
10.0
1.0
100
1000
10,000
100,000
MN
KN
FK
TFO
MO
LAO
PG
WH2
RK
CPO
HN
UBO
WMO
NP
SV3

Figure 9

Code	Station	Distance (km)	Geographic Latitude	Geographic Longitude	Elav. (km)	Computed Azimuth Epi. Sta.	Computed Azimuth Sta. Epi.	Installed Azimuth Tang.	Installed Azimuth Radial	Large or Small SP	LP Inst.
MN-NV*	Mina, Nevada	240	38°26'10" N	118°08'53" W	1.52	309°	127°	308°	038°	L	x
KN-UT*	Kanab, Utah	283	37°01'22" N	112°49'39" W	1.74	91°	273°	95°	185°	L	
TFSO-Z60	Tonto Forest Seismological Observatory, Arizona	530	34°17'12" N	111°16'03" W	1.49	125°	307°	90°	0°	JM	x
MO-ID*	Mountain Home, Idaho	664	43°04'19" N	116°15'56" W	.79	358°	178°	359°	89°	L	x
UBSO-Z10	Uinta Basin Seismological Observatory, Utah	664	40°19'18" N	109°34'07" W	1.60	55°	239°	90°	0°	JM	x
FK-CO*	Franktown, Colorado	1045	39°35'12" N	104°27'42" W	1.80	71°	258°	79°	169°	L	x
LAO	Subarray AO-10, Montana	1337	46°41'19" N	106°13'20" W	.90	34°	221°	90°	0°	HSZ	x
WMSO-Z6	Wichita Mountain Seismo-logical Observatory, Oklahoma	1592	34°43'05" N	98°35'21" W	.51	94°	235°	90°	0°	JM	x
KC-MO	Kansas City, Missouri	1881	39°21'21" N	94°40'17" W	.27	76°	269°	133°	223°	S	x
PG-BC	Prince George, British Columbia, Canada	1945	53°59'50 N	122°31'23" W	.91	347°	162°	110°	200°	L	x
RK-ON*	Red Lake, Ontario,Canada	2339	50°50'20" N	93°40'20" W	.37	42°	238°	58°	148°	S	x
CPSO-Z8	Cumberland Plateau Seismological Observatory, Tennessee	2726	35°35°41" N	85°34'13" W	.57	84°	283°	90°	0°	JM	x
WH2YK*	Whitehorse, Yukon Territory, Canada	2947	60°41'41" N	134°58'02" W	.85	339°	144°	325°	055°	L	x
HN-ME*	Houlton, Maine	4062	46°09'43" N	67°59'09" W	.21	60°	273°	93°	183°	S	x
SV3QB	Schefferville, Quebec, Canada	4185	54°48'39" N	66°45'00" W	.58	45°	263°	139°	229°	S	x
NP-NT*	Mould Bay, Northwest Territories, Canada	4368	76°15'08" N	119°22'18" W	.06	359°	176°	356°	86°	JMZ S	x

*Seismometers Oriented Toward Nevada Test Site

Recording Site Information - BOURBON
Appendix I(A)

Unified Magnitude: $m = \log_{10} (A/T)_{,} + B$

where

A = zero to peak ground motion in millimicrons

$= \frac{(mm)\ (1000)}{K}$

T = signal period in seconds

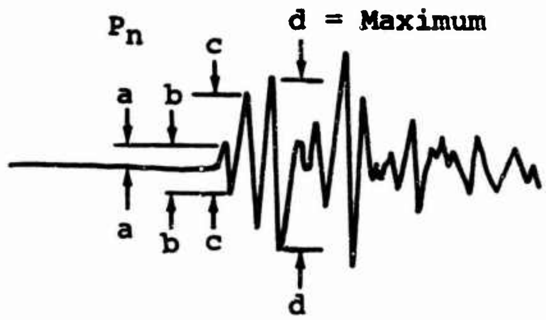
B = distance factor (see Table below)

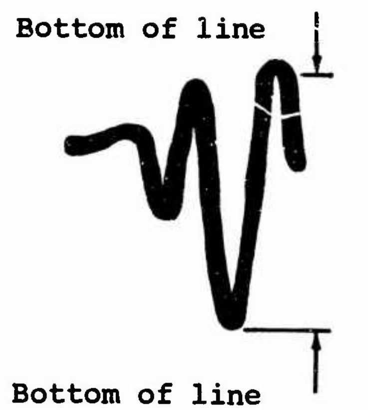
mm = record amplitude in millimeters zero to peak

K = magnification in thousands at signal frequency

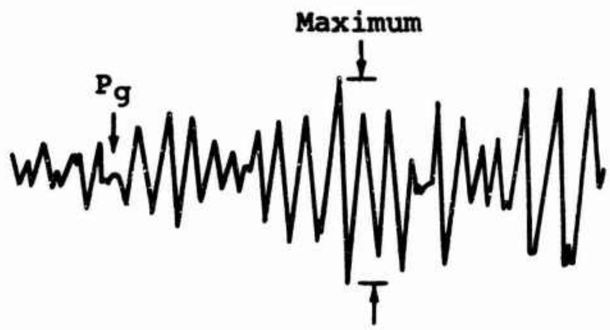
Table of Distance Factors (B) for Zero Depth

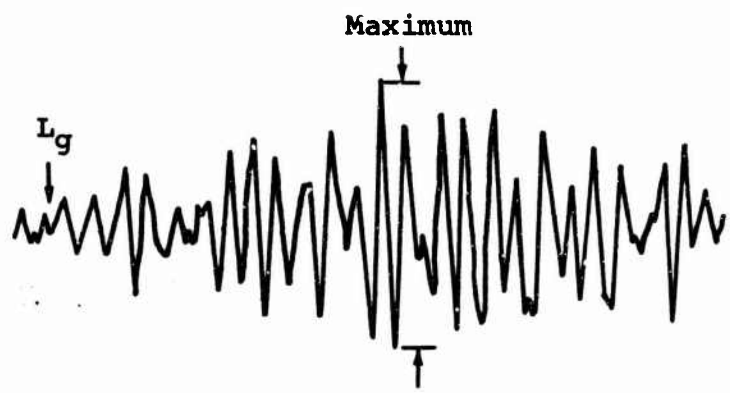
Dist (deg)	B	Dist (deg)	B	Dist (deg)	B	Dist (deg)	B
0°	-	27°	3.5	54°	3.8	80°	3.7
1	-	28	3.6	55	3.8	81	3.8
2	2.2	29	3.6	56	3.8	82	3.9
3	2.7	30	3.6	57	3.8	83	4.0
4	3.1	31	3.7	58	3.8	84	4.0
5	3.4	32	3.7	59	3.8	85	4.0
6	3.6	33	3.7	60	3.8	86	3.9
7	3.8	34	3.7	61	3.9	87	4.0
8	4.0	35	3.7	62	4.0	88	4.1
9	4.2	36	3.6	63	3.9	89	4.0
10	4.3	37	3.5	64	4.0	90	4.0
11	4.2	38	3.5	65	4.0	91	4.1
12	4.1	39	3.4	66	4.0	92	4.1
13	4.0	40	3.4	67	4.0	93	4.2
14	3.6	41	3.5	68	4.0	94	4.1
15	3.3	42	3.5	69	4.0	95	4.2
16	2.9	43	3.5	70	3.9	96	4.3
17	2.9	44	3.5	71	3.9	97	4.4
18	2.9	45	3.7	72	3.9	98	4.5
19	3.0	46	3.8	73	3.9	99	4.5
20	3.0	47	3.9	74	3.8	100	4.4
21	3.1	48	3.9	75	3.8	101	4.3
22	3.2	49	3.8	76	3.9	102	4.4
23	3.3	50	3.7	77	3.9	103	4.5
24	3.3	51	3.7	78	3.9	104	4.6
25	3.5	52	3.7	79	3.8	105	4.7
26	3.4	53	3.7				





Detail Showing Allowance
For Line Width





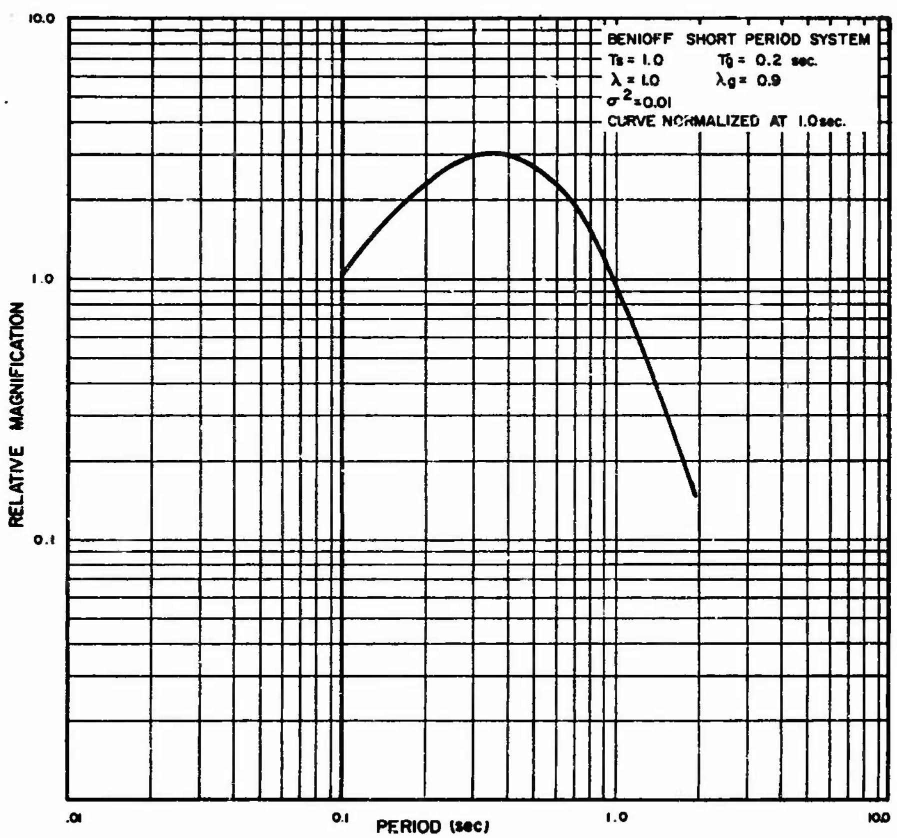
Pick <u>time</u> of <u>Pn</u> at beginning of "a" half cycle.

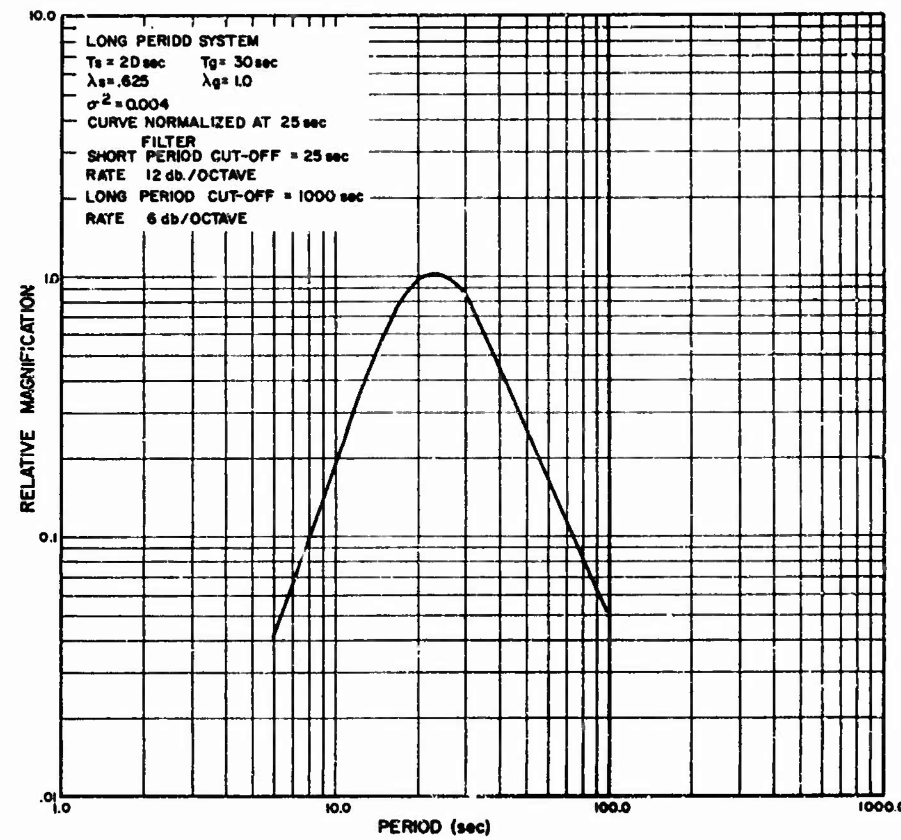
Pick <u>amplitude</u> of <u>Pn</u> as maximum "$d/_2$" within 2 or 3 cycles of "c".

Pick <u>amplitudes</u> of <u>Pg</u> and <u>Lg</u> at maximum of corresponding motion.

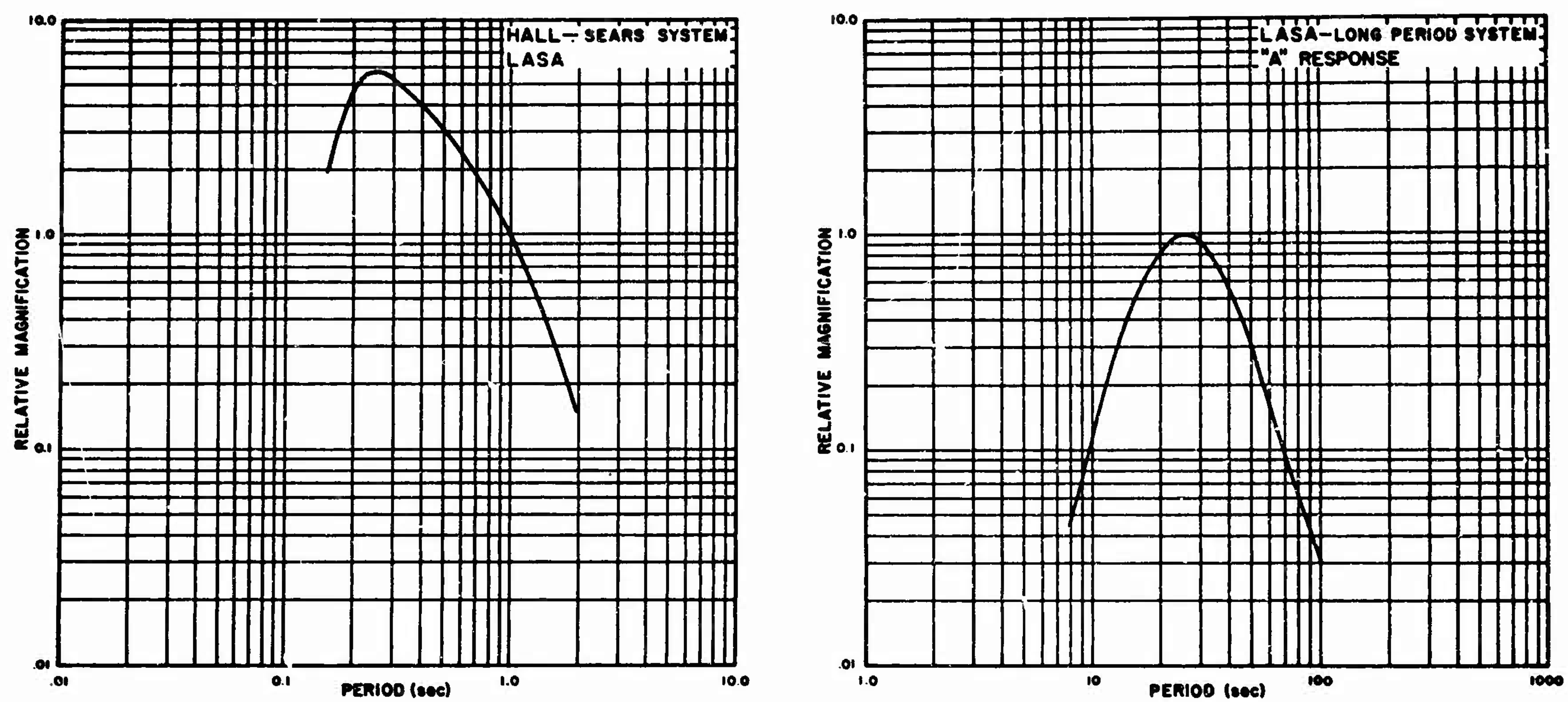
Seismic Analysis Diagram

APPENDIX II(A)

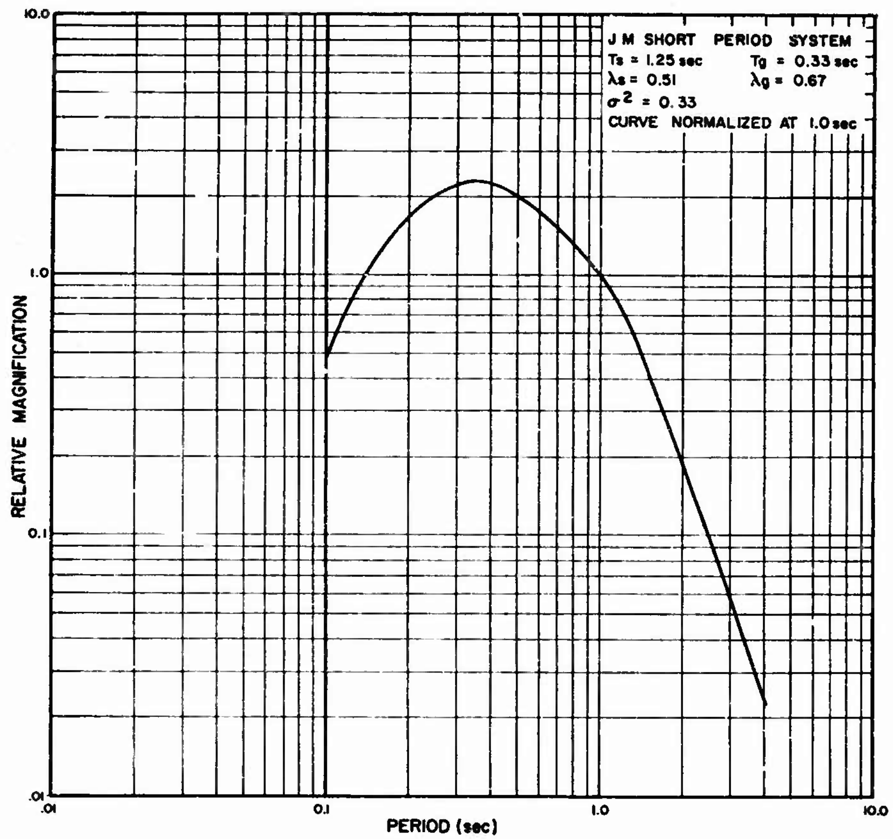


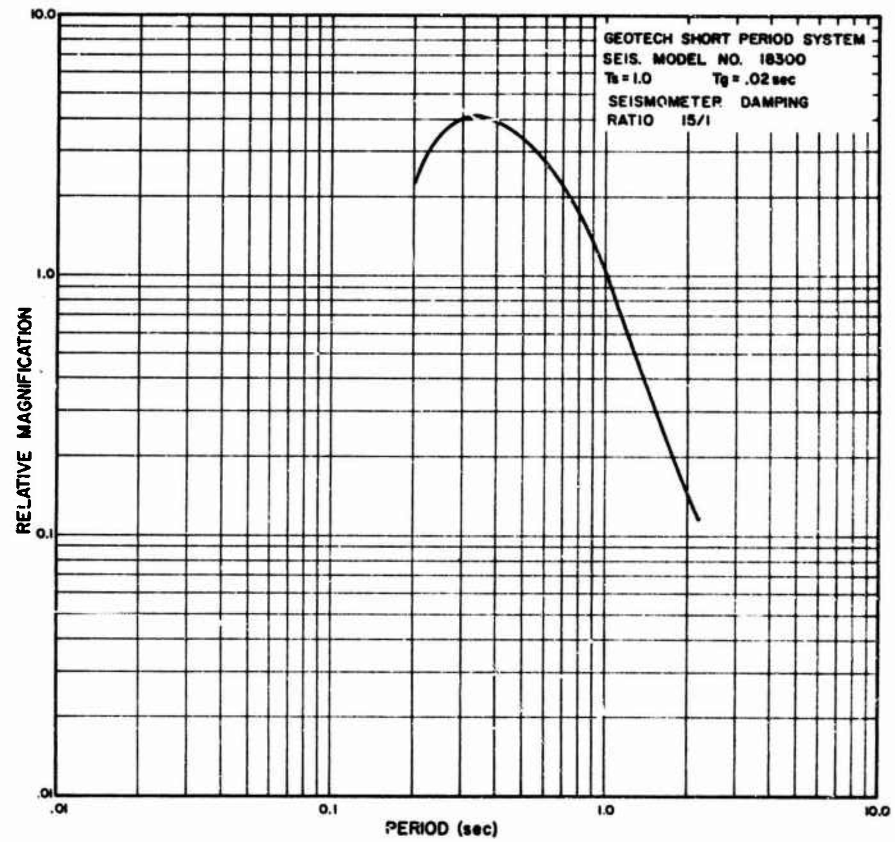


INSTRUMENT RESPONSE CURVES - LRSM



INSTRUMENT RESPONSE CURVE - LASA





INSTRUMENT RESPONSE CURVES - OTHER SHORT PERIOD

APPENDIX II(D)

Unclassified
Security Classification

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1. ORIGINATING ACTIVITY (Corporate author) TELEDYNE, INC. ALEXANDRIA, VIRGINIA	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP -------

3. REPORT TITLE

LONG RANGE SEISMIC MEASUREMENTS - BOURBON

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Scientific

5. AUTHOR(S) (Last name, first name, initial)

Don M. Clark

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
20 January 1967	23	2

8a. CONTRACT OR GRANT NO. F 33657-67-C-1313 b. PROJECT NO. VELA T/6702 c. ARPA Order No. 624 d. ARPA Program Code No. 5810	9a. ORIGINATOR'S REPORT NUMBER(S) 185 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) --------

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11. SUPPLEMENTARY NOTES ------	12. SPONSORING MILITARY ACTIVITY ADVANCED RESEARCH PROJECTS AGENCY NUCLEAR TEST DETECTION OFFICE WASHINGTON, D. C.

13. ABSTRACT

An analysis of seismological data from an underground nuclear explosion as a continuing study to provide information to aid in distinguishing between earthquakes and explosions. A table of travel-times and amplitudes of P, Pg, Lg, and surface waves are included along with other unidentified phases.

DD FORM 1 JAN 64 1473

Unclassified
Security Classification

Unclassified
Security Classification

14 KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Seismic Magnitude						
Seismic Travel-Time						
Seismic Amplitude						
VELA-UNIFORM						
Nuclear Tests						

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Unclassified
Security Classification

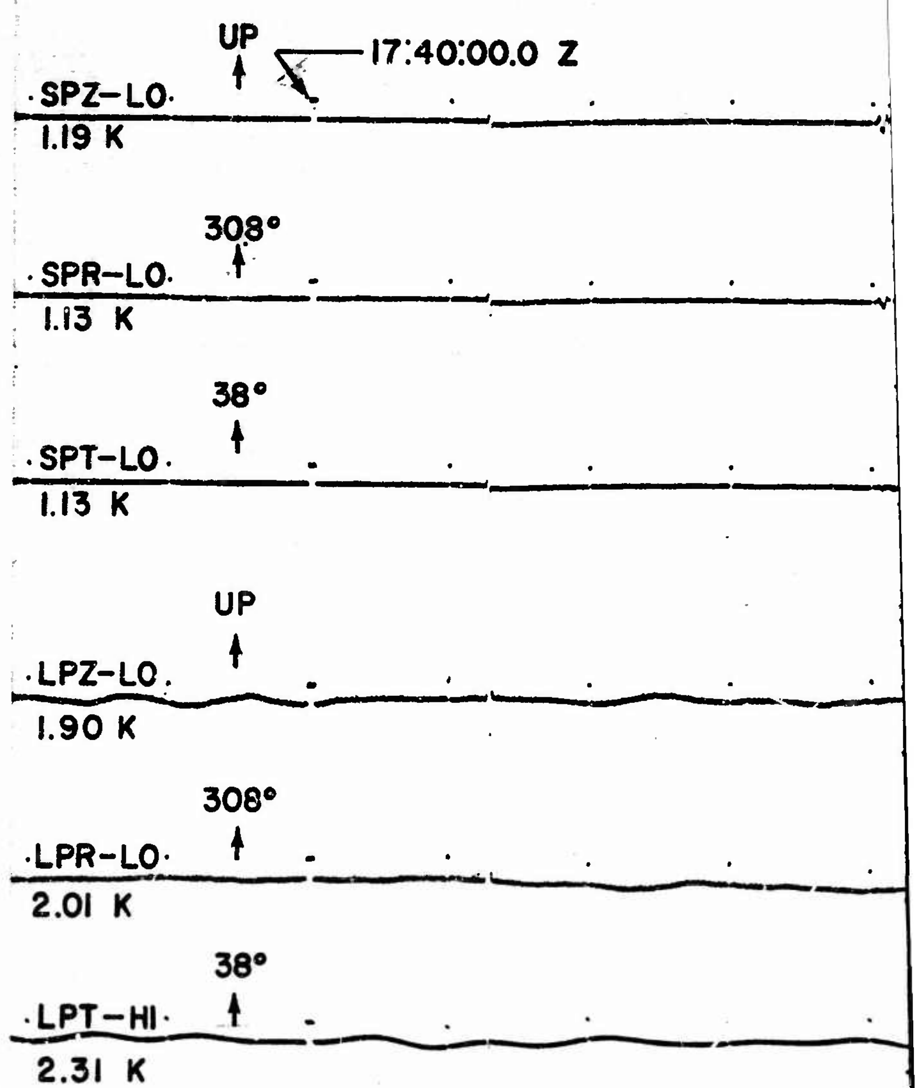
BOURBON

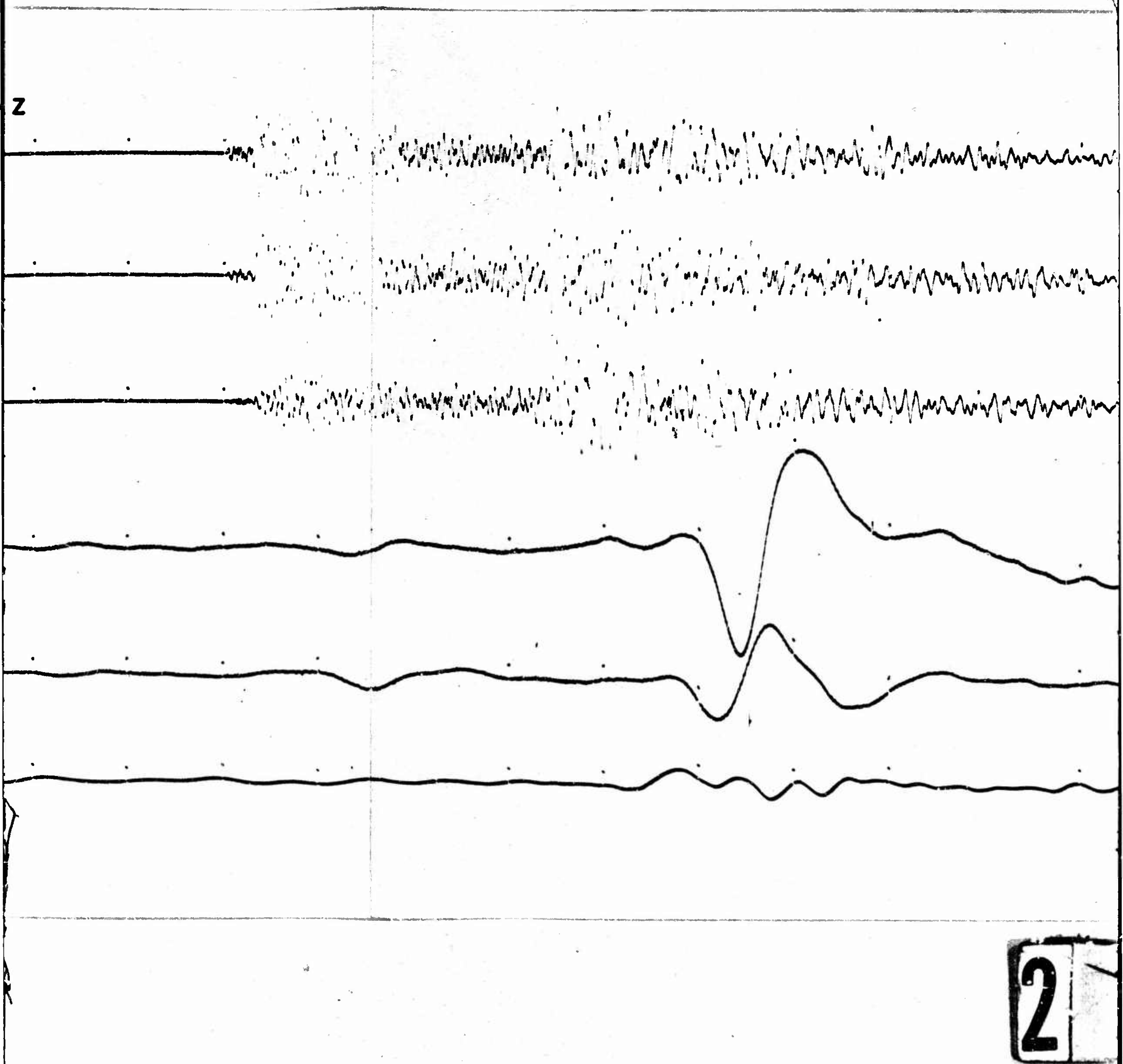
MN-NV

MINA, NEVADA

20 JANUARY 1967

Δ = 240 km

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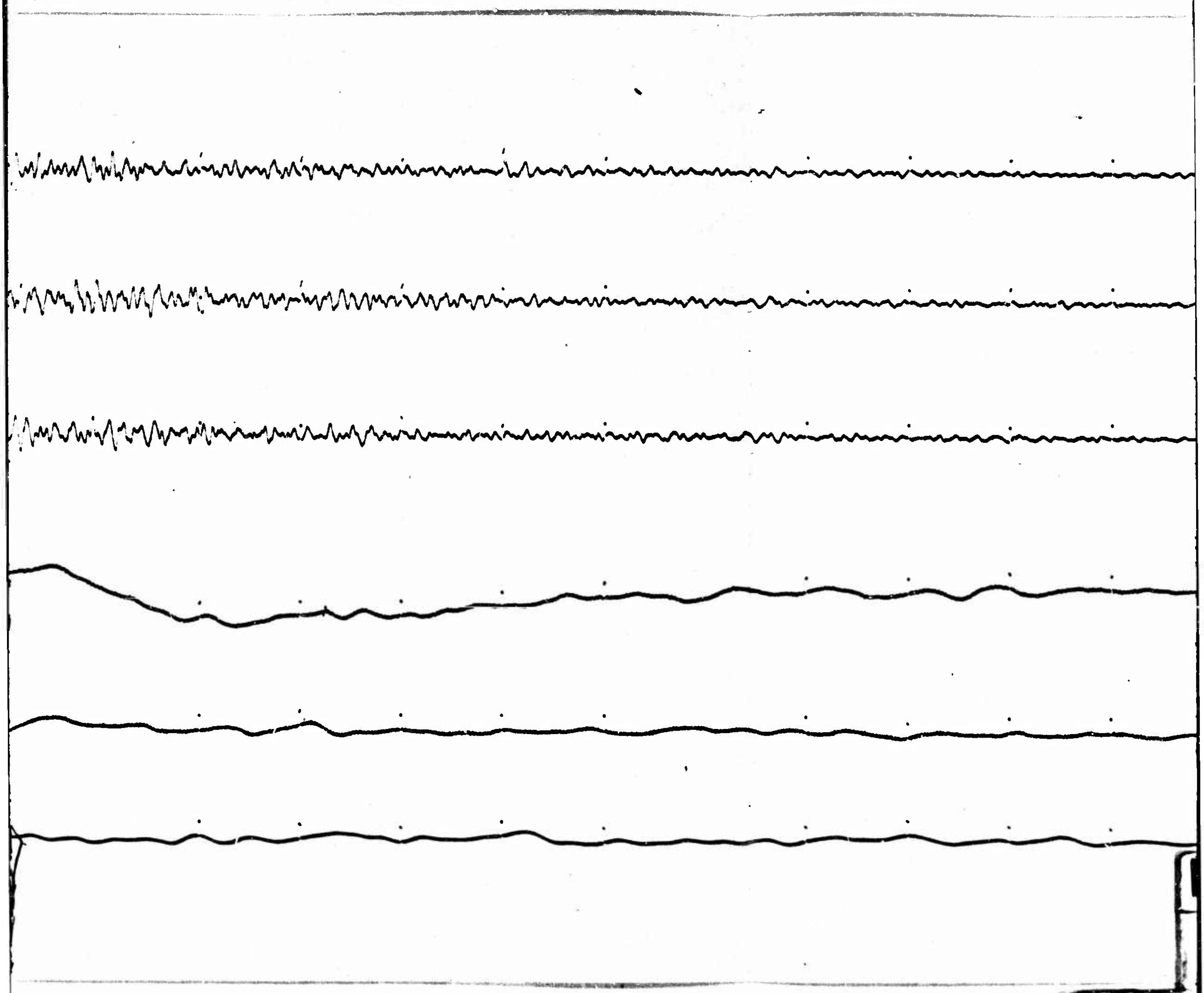

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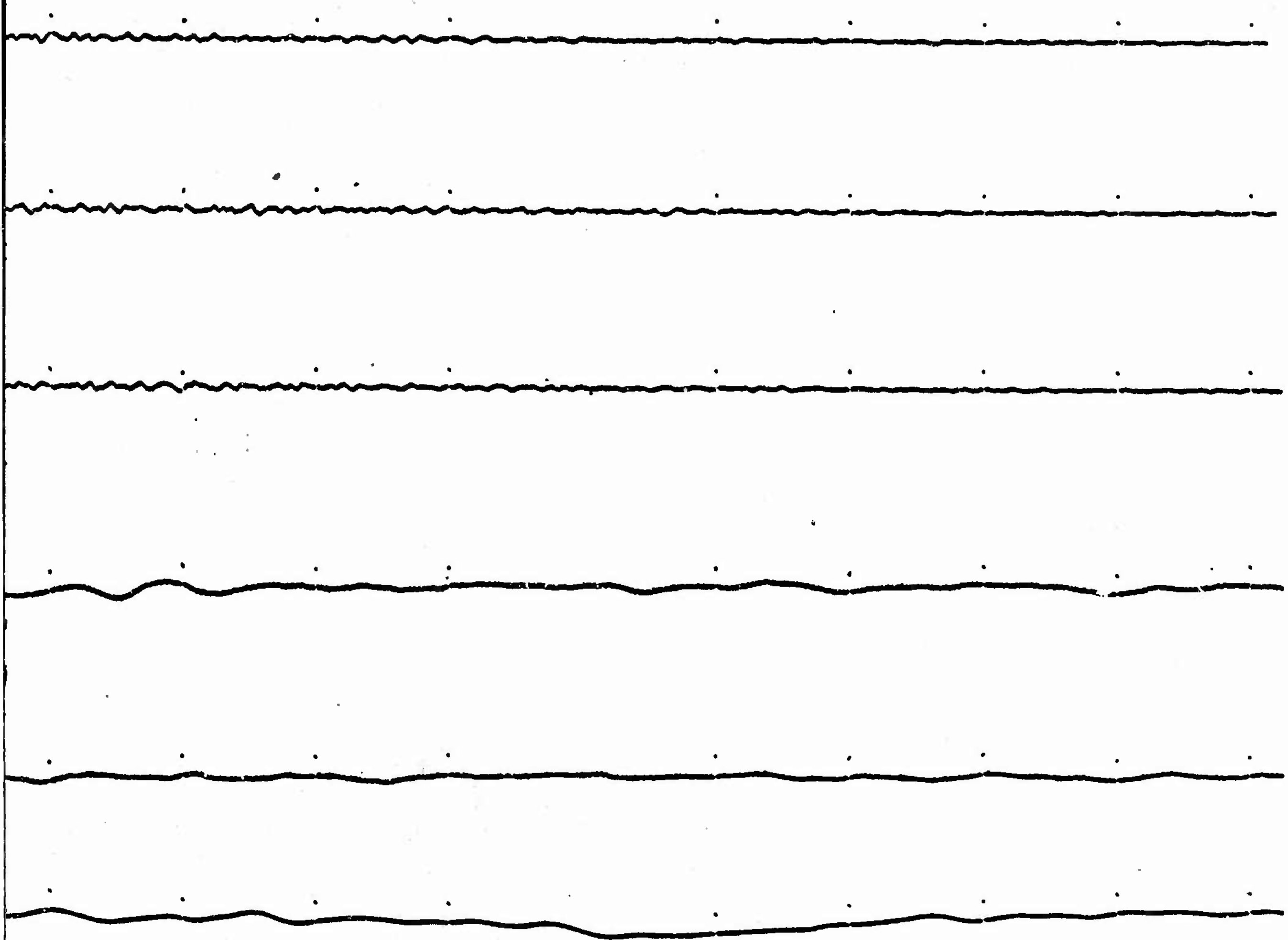


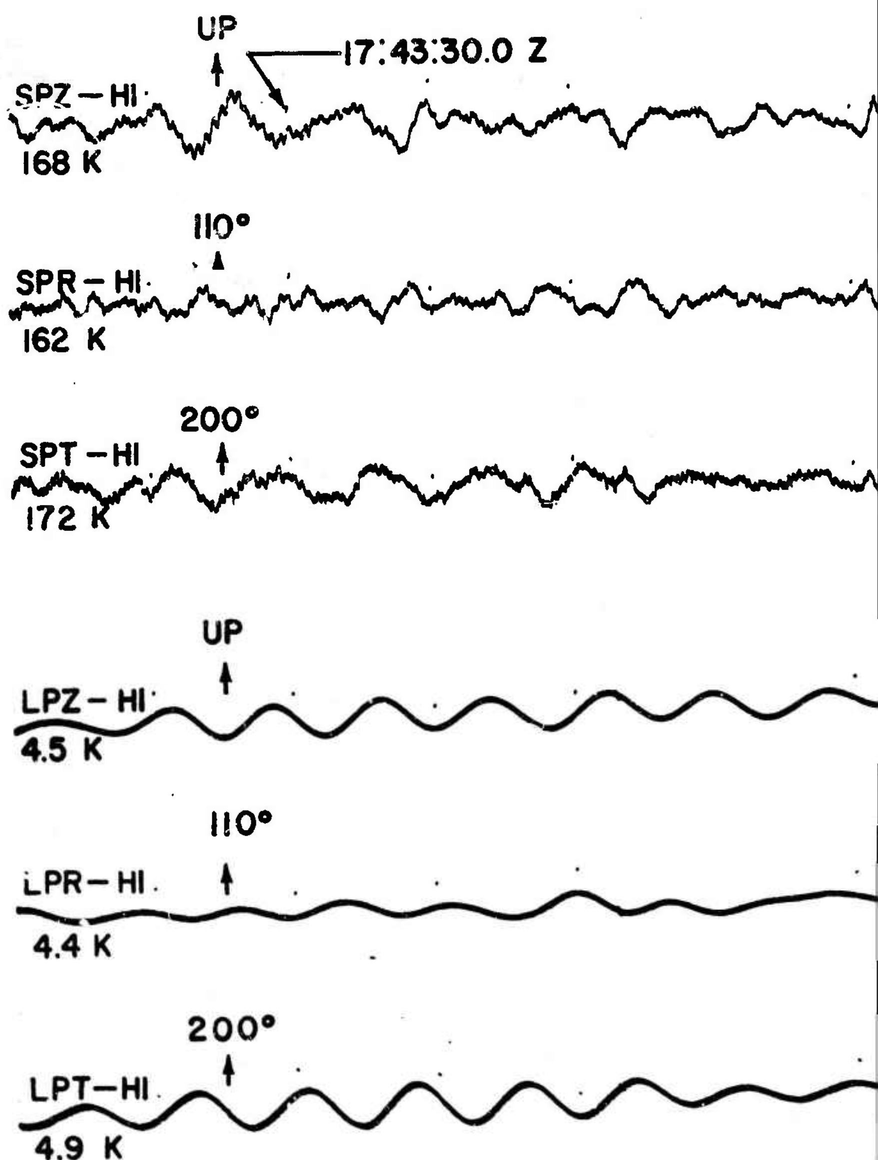
BOURBON

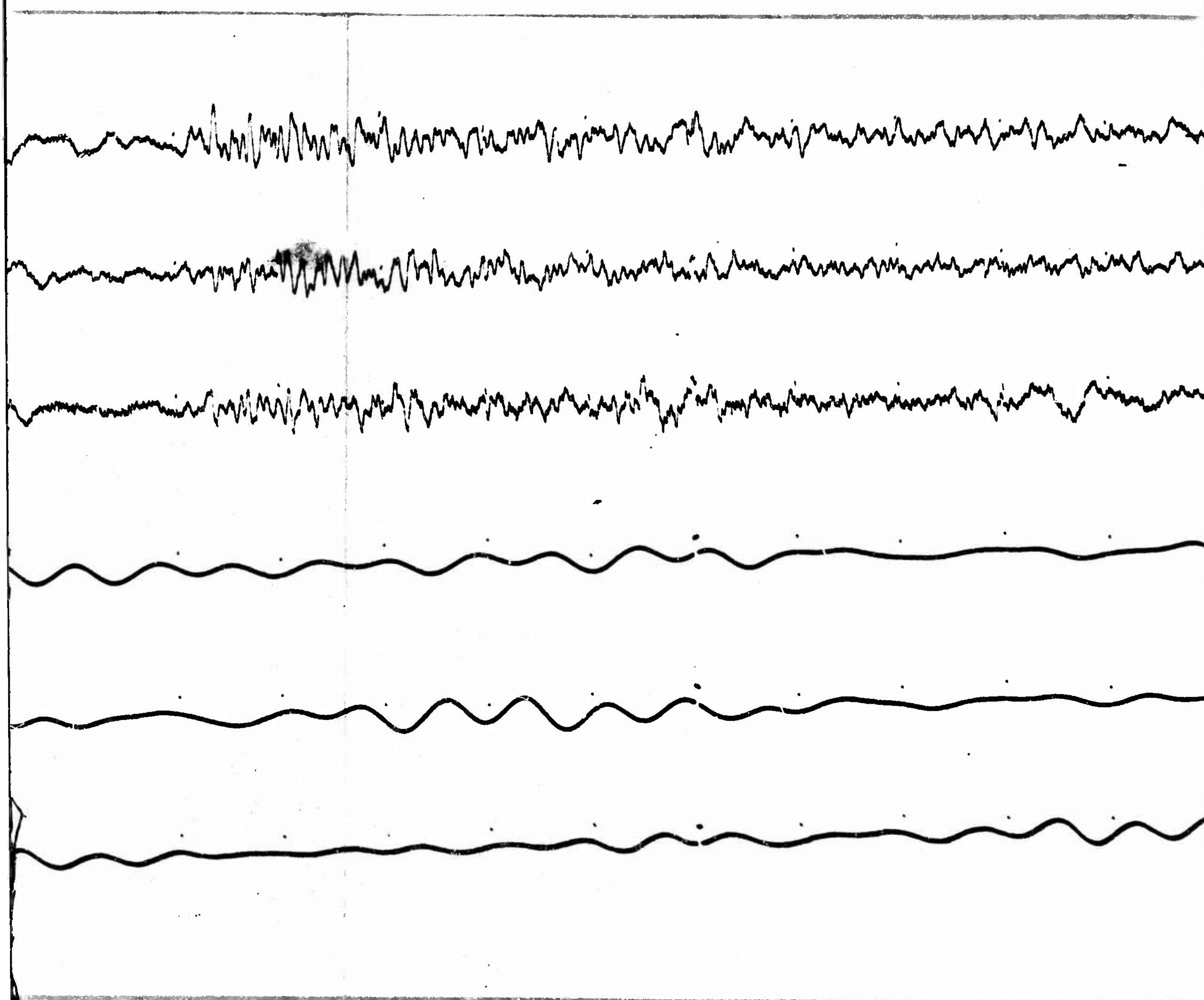
PG-BC

PRINCE GEORGE, BRITISH COLUMBIA

20 JANUARY 1967

Δ = 1945





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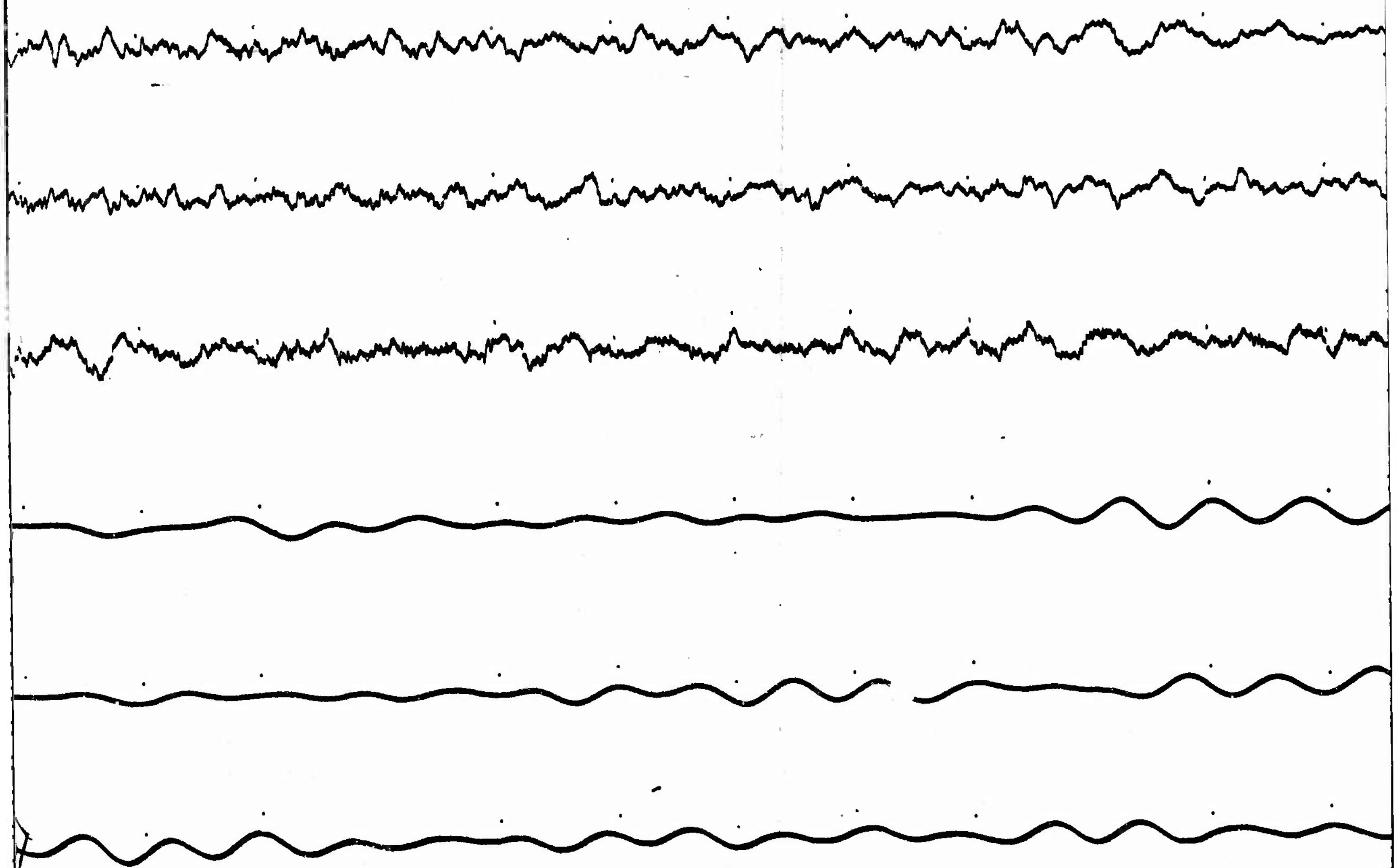

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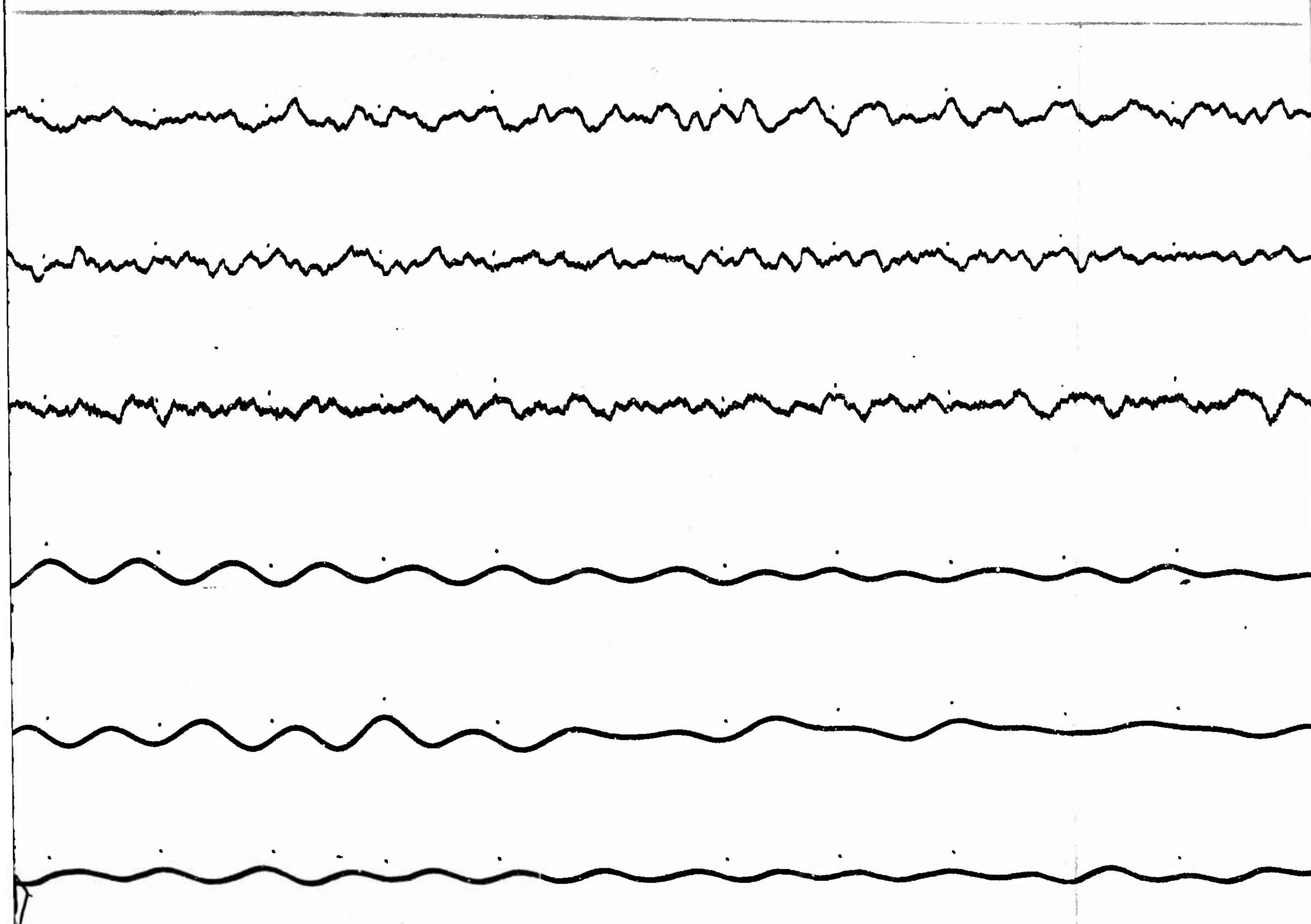

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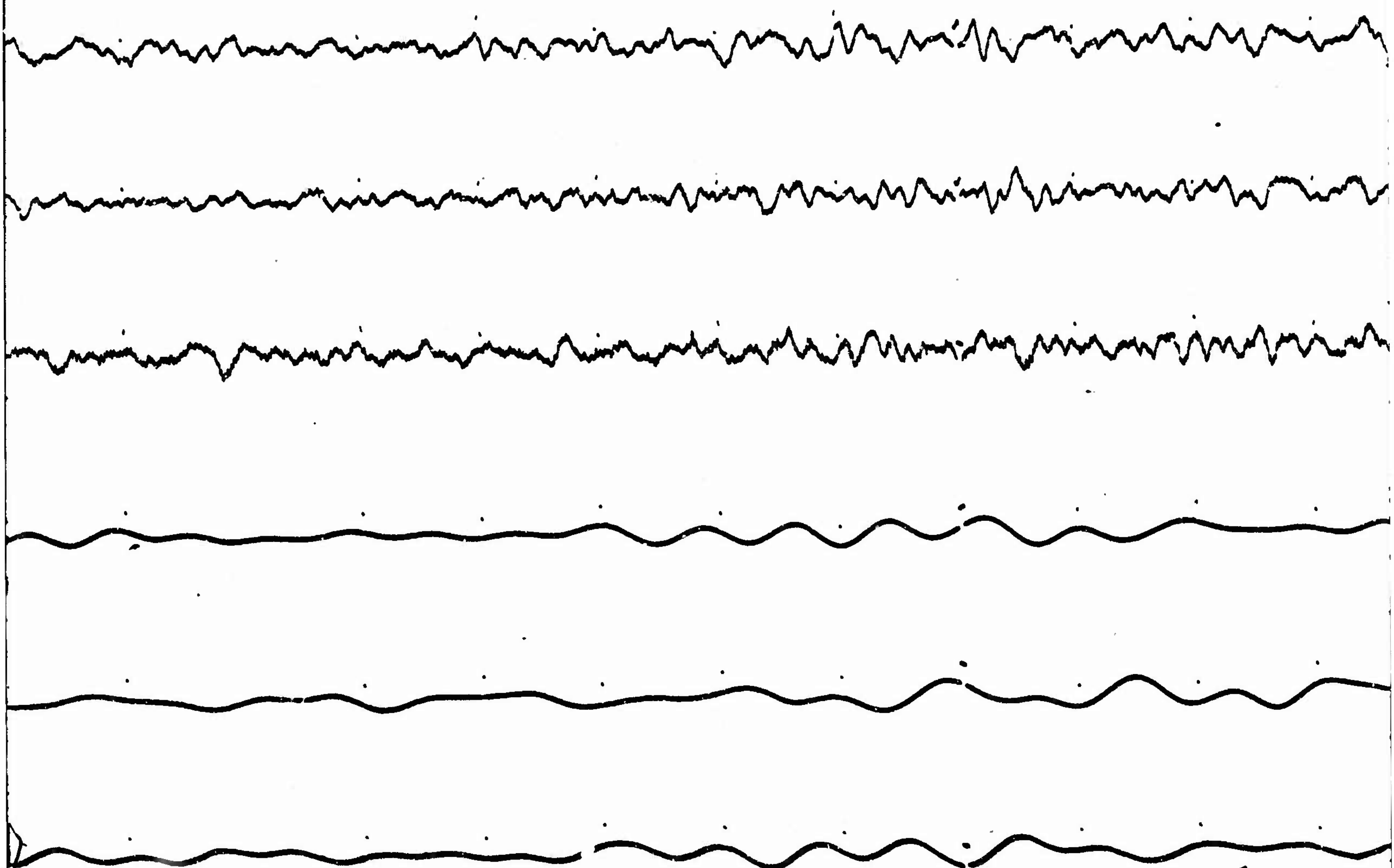

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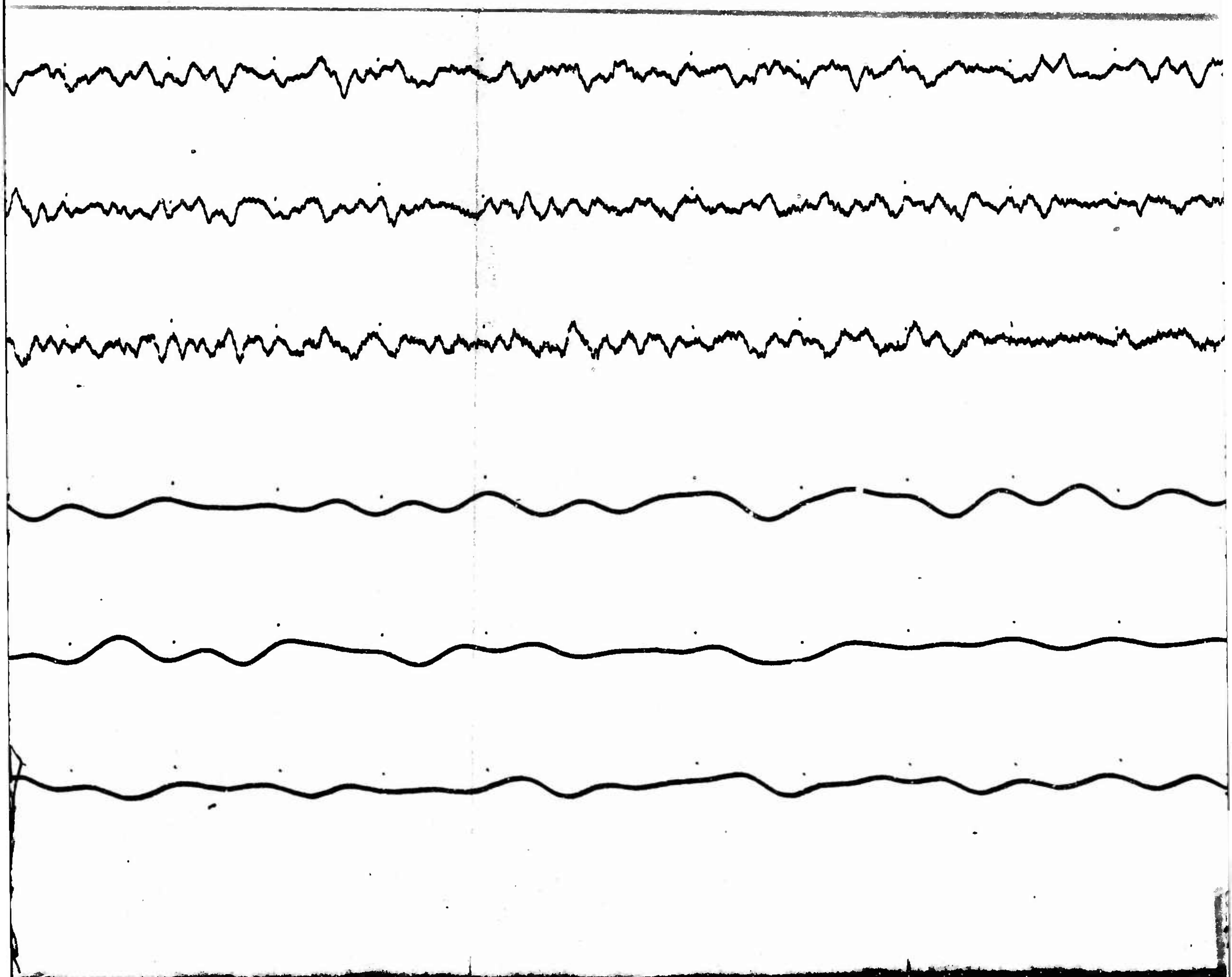

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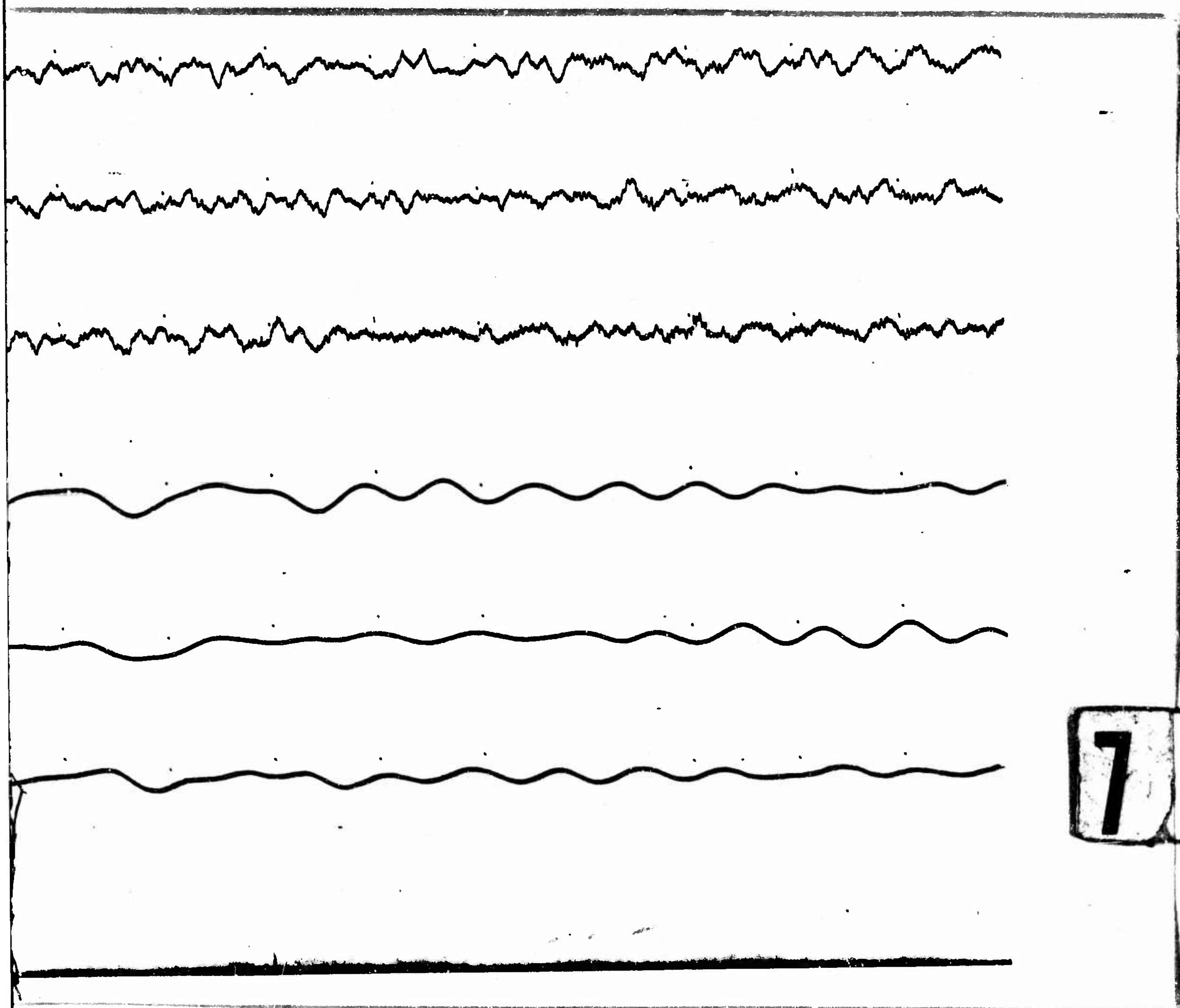

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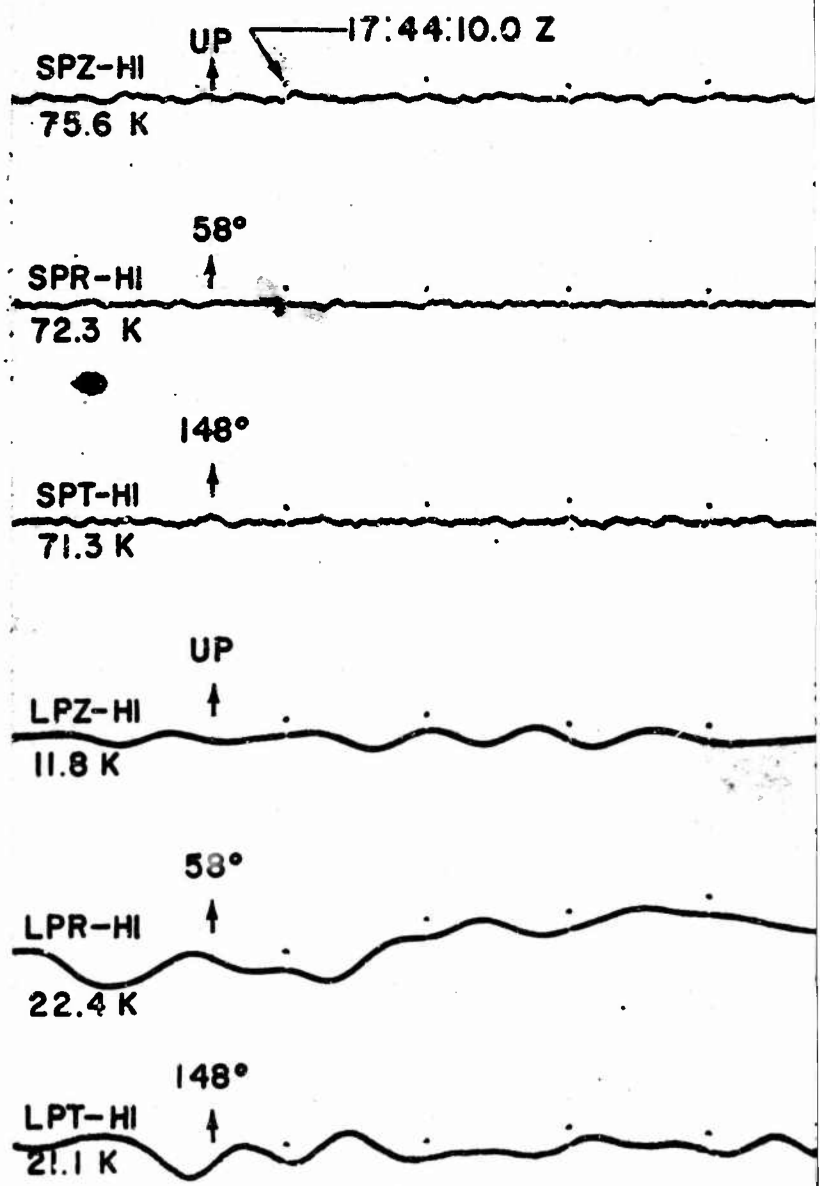
BOURBON

RK-ON

RED LAKE, ONTARIO

20 JANUARY 1967

Δ = 2339



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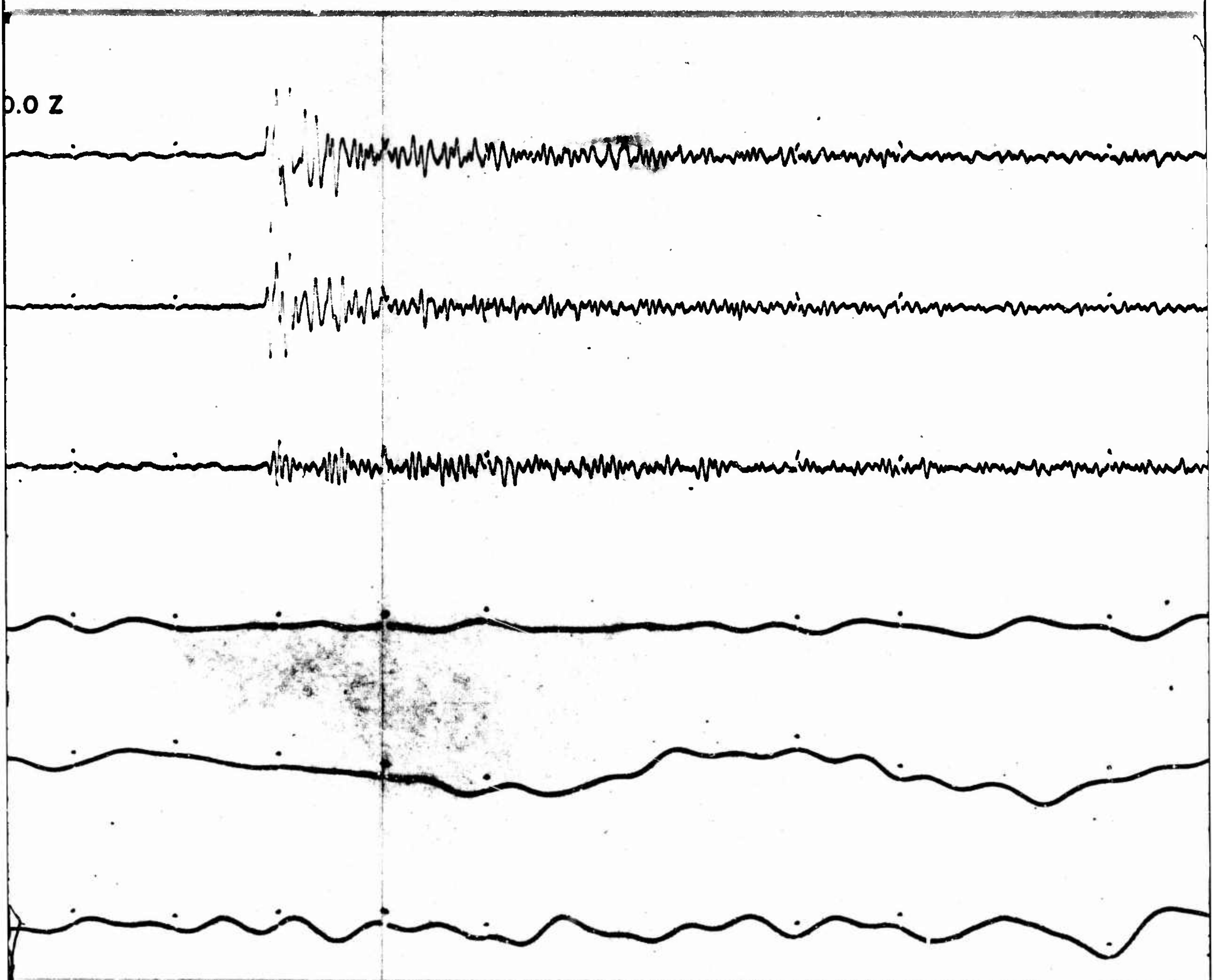

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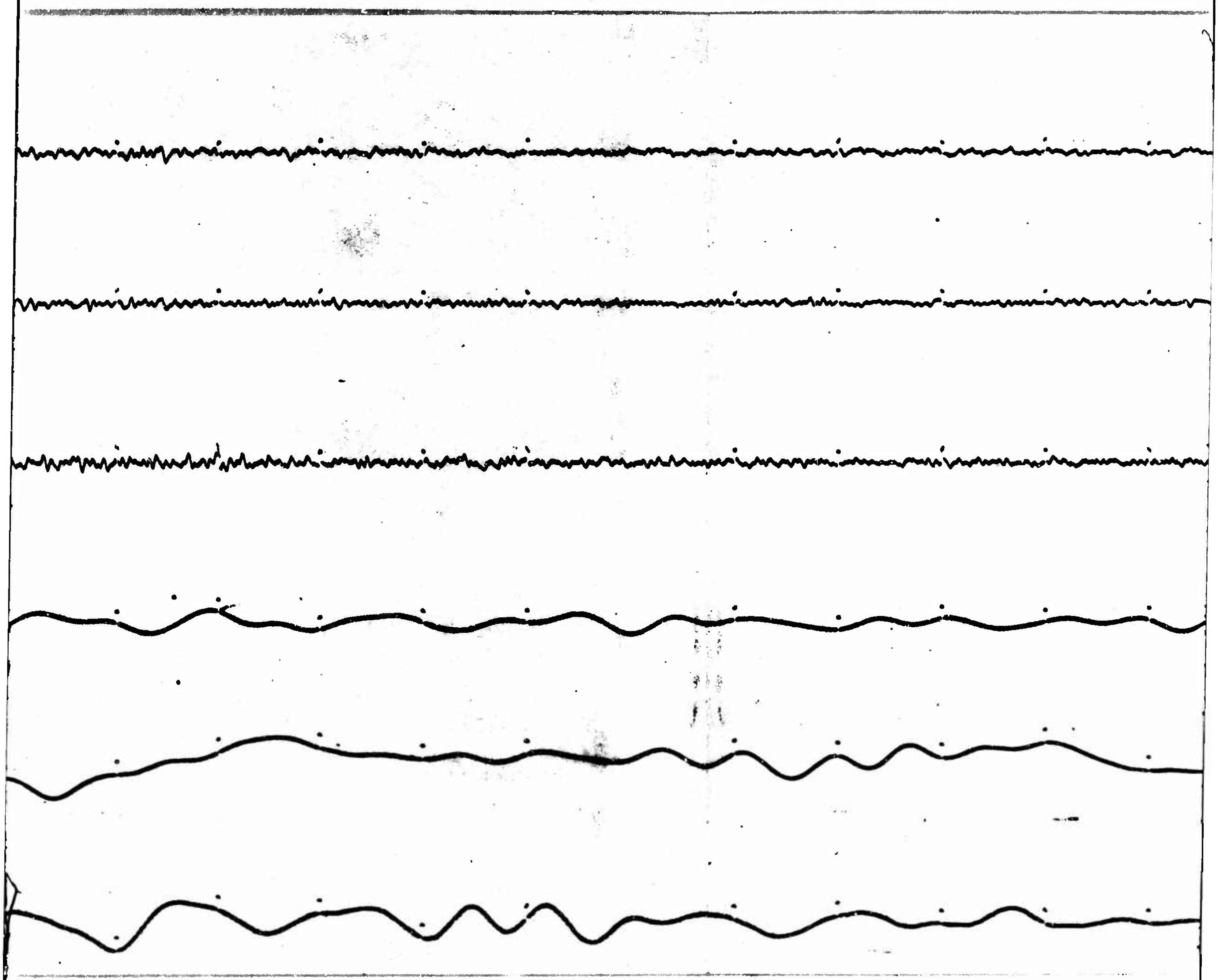

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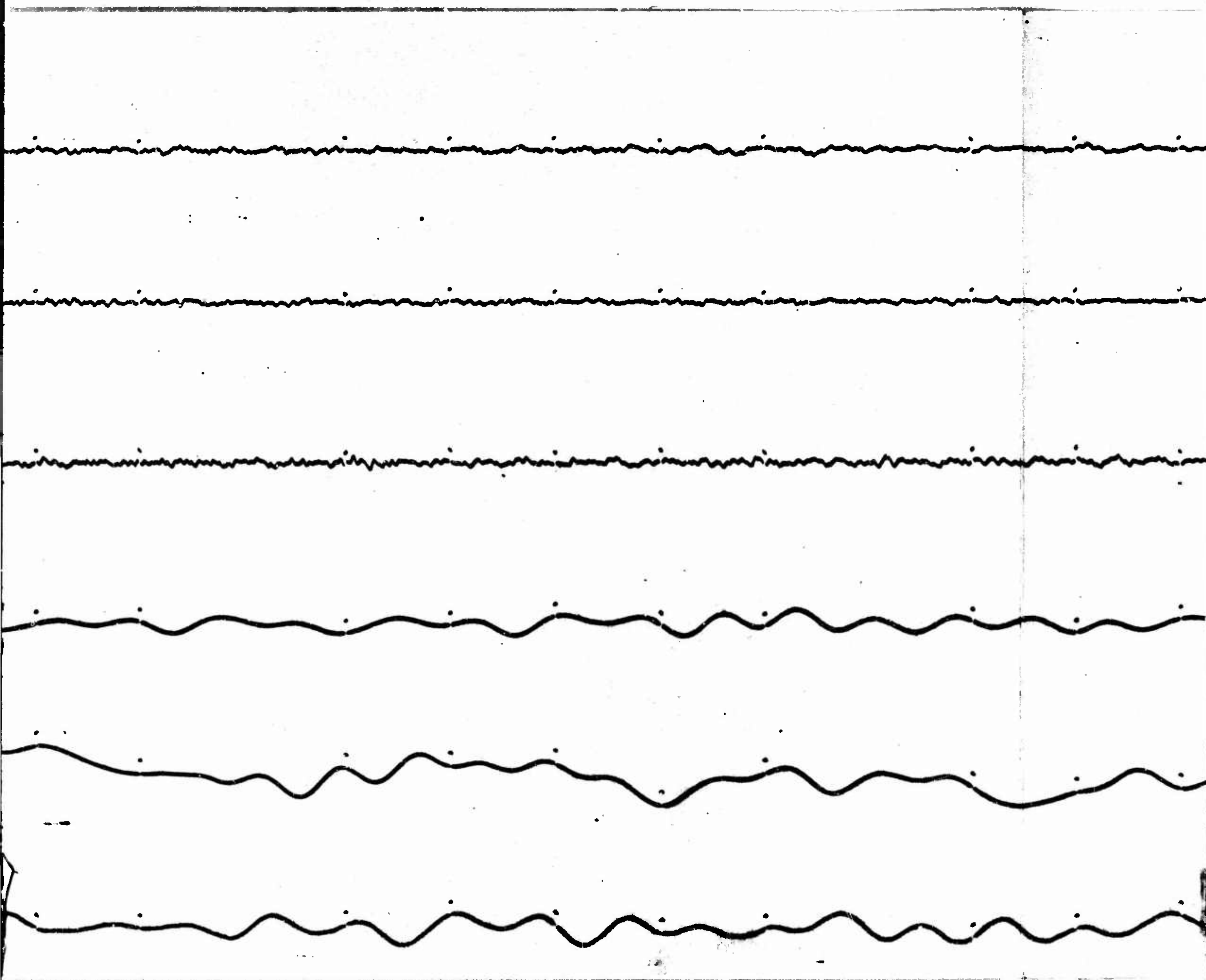

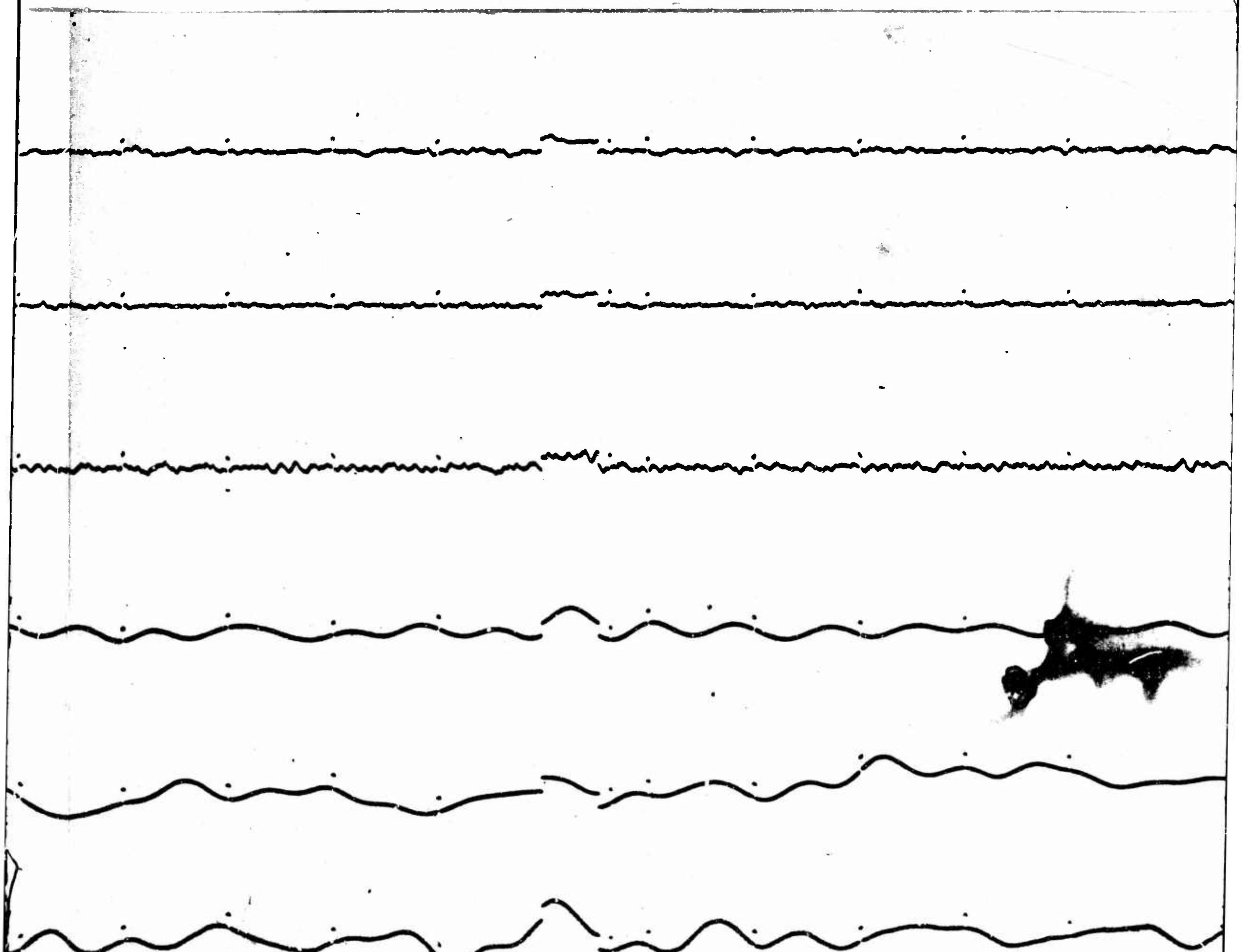

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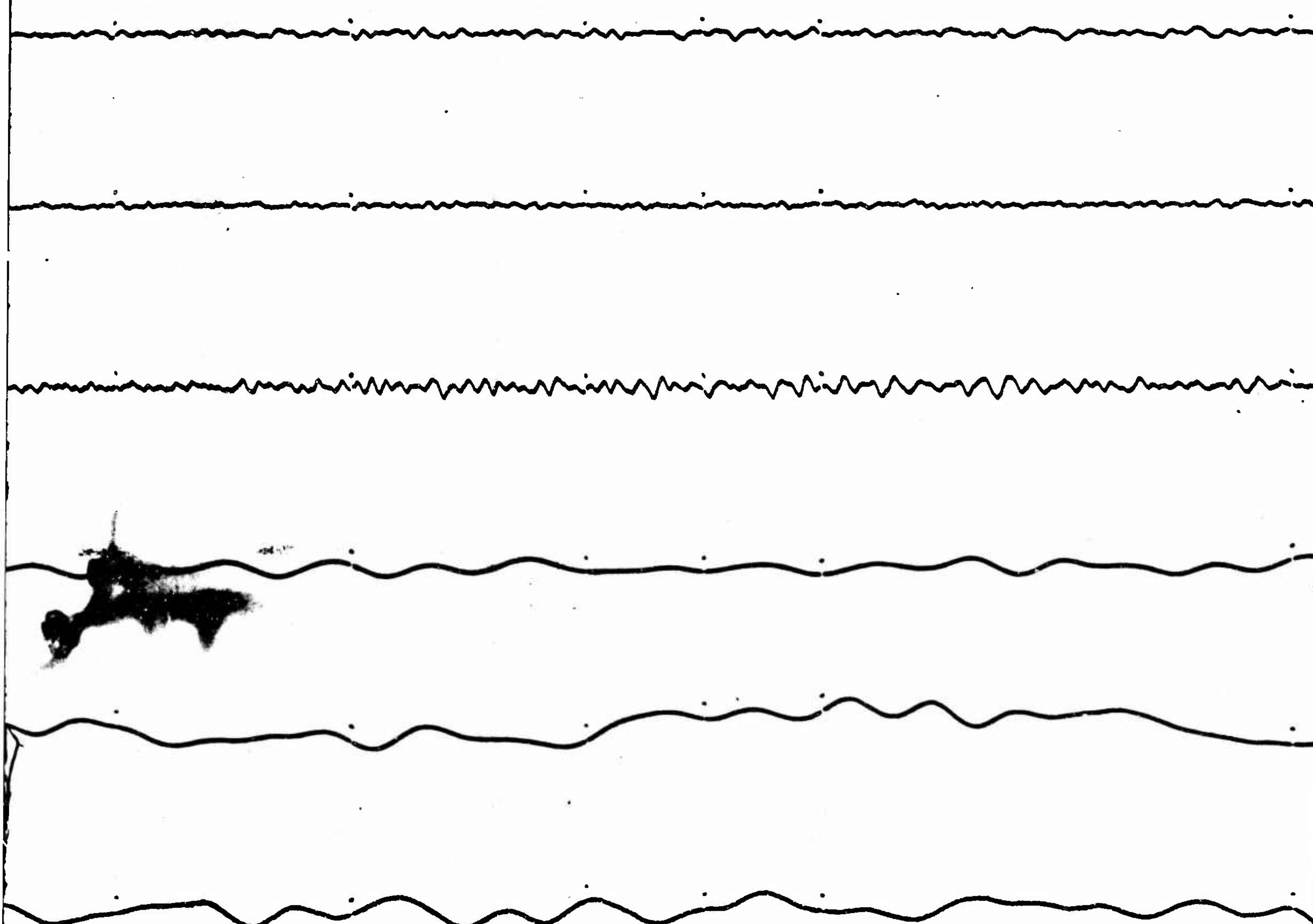

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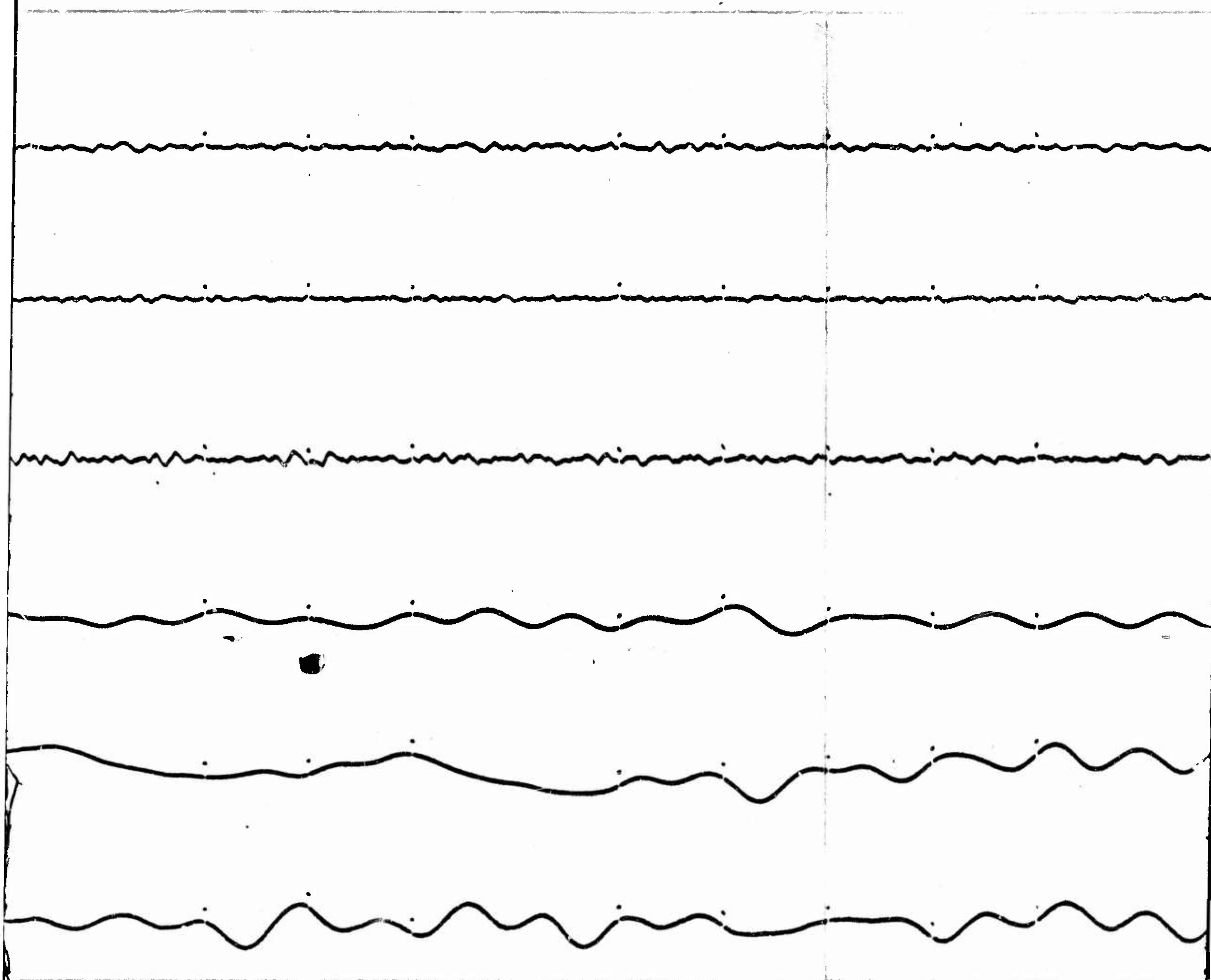

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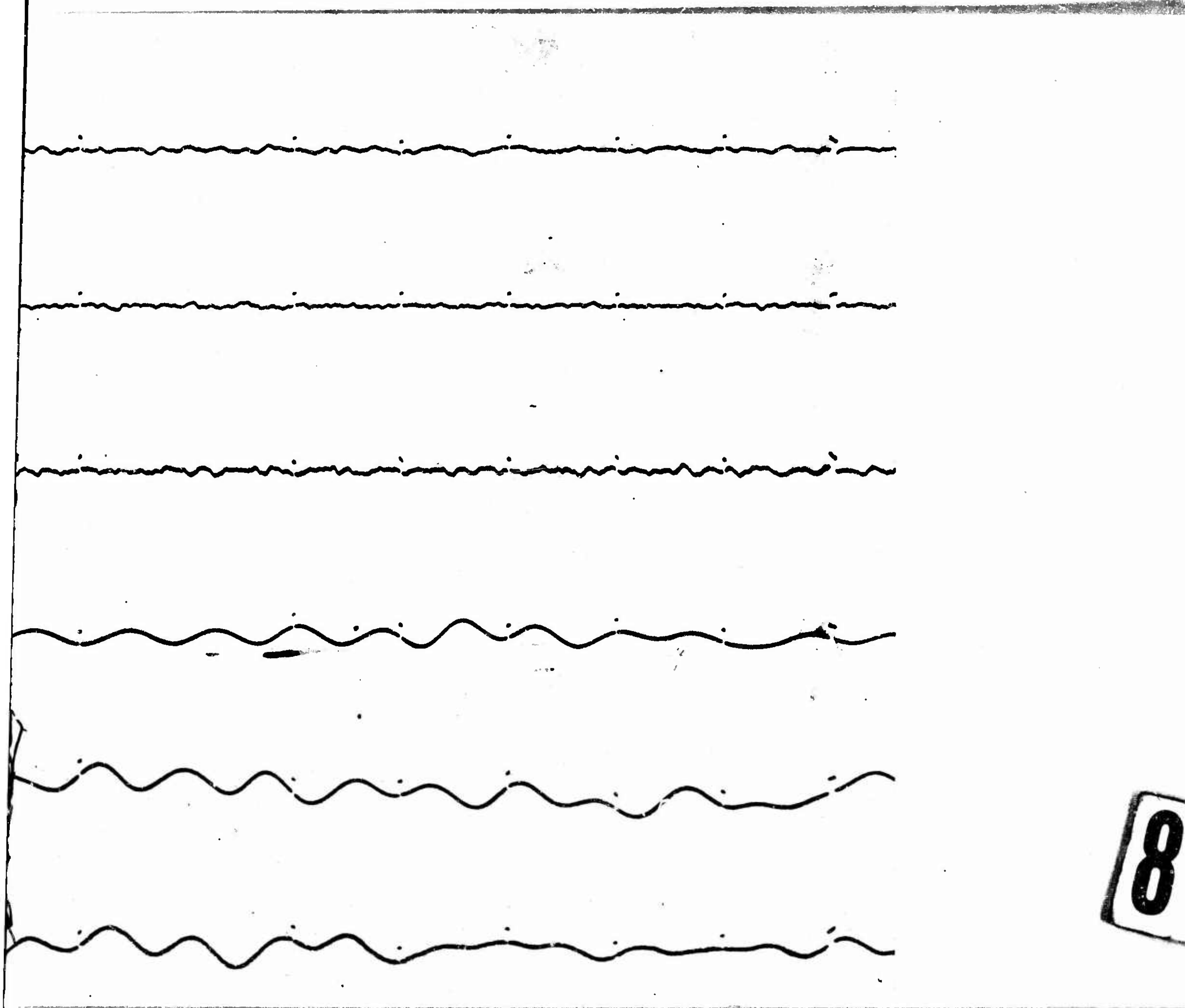


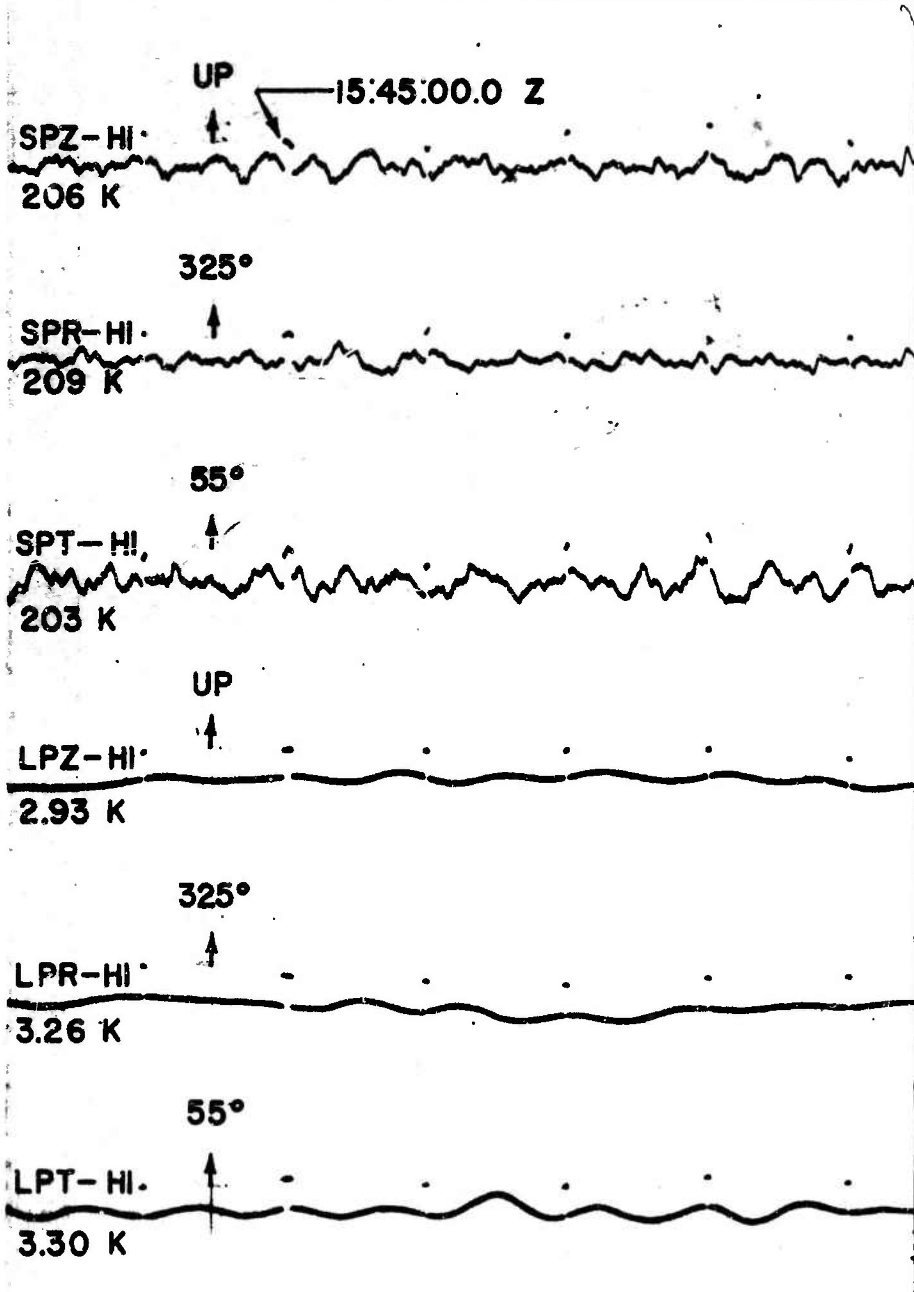
BOURBON

WH2YK

WHITEHORSE, YUKON TERRITORIES

20 JANUARY 1967

Δ = 2947 km



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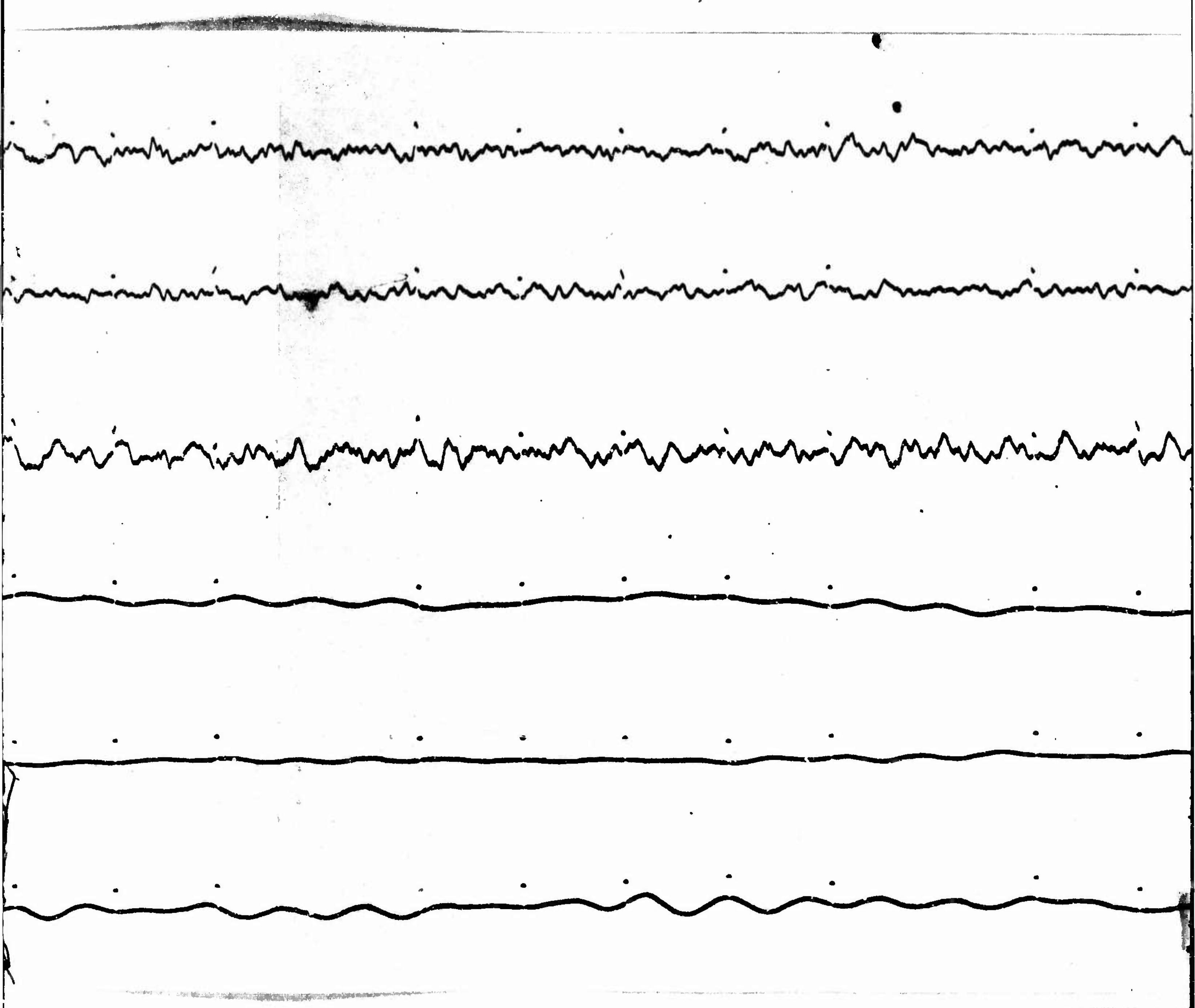

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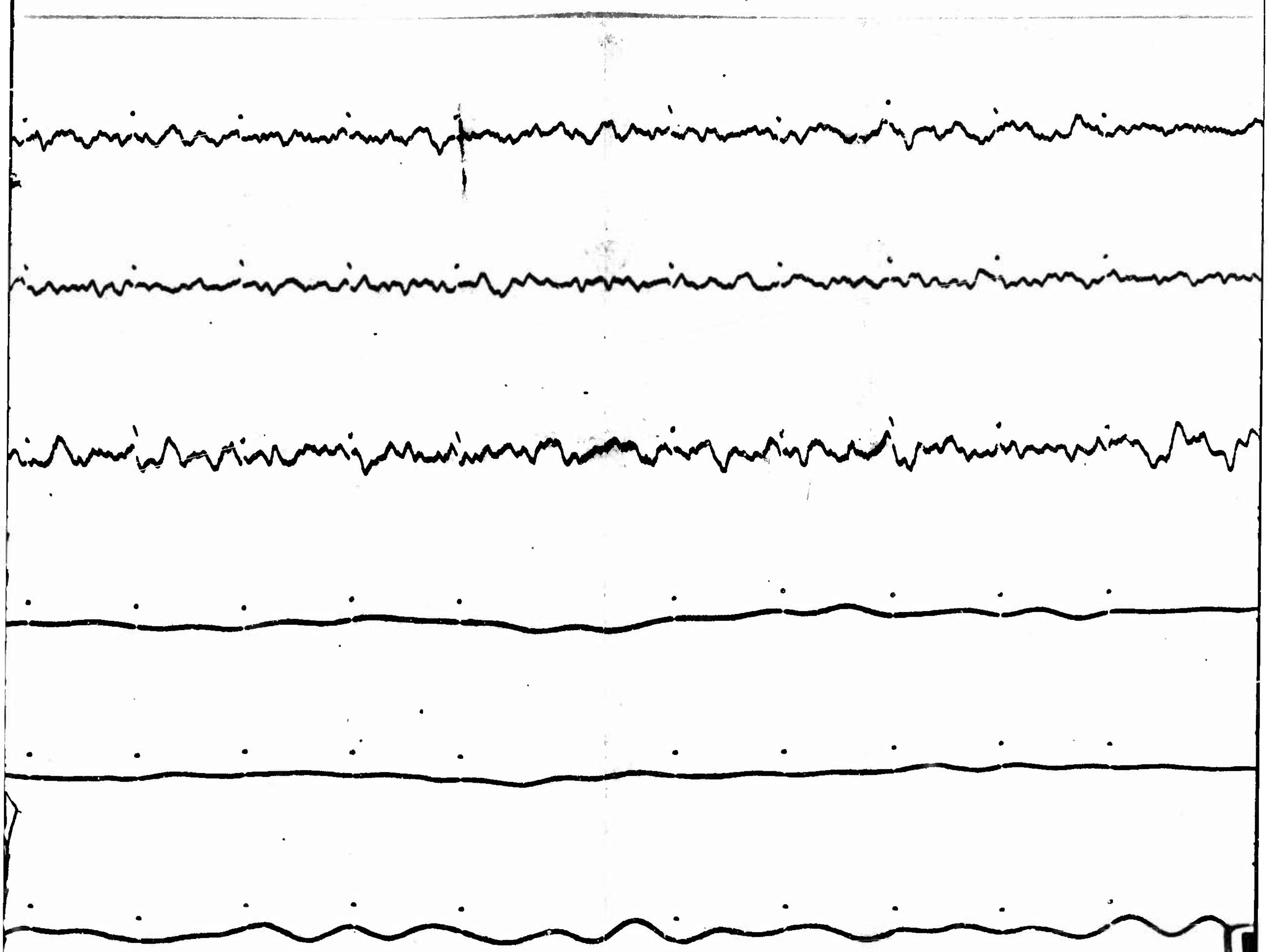

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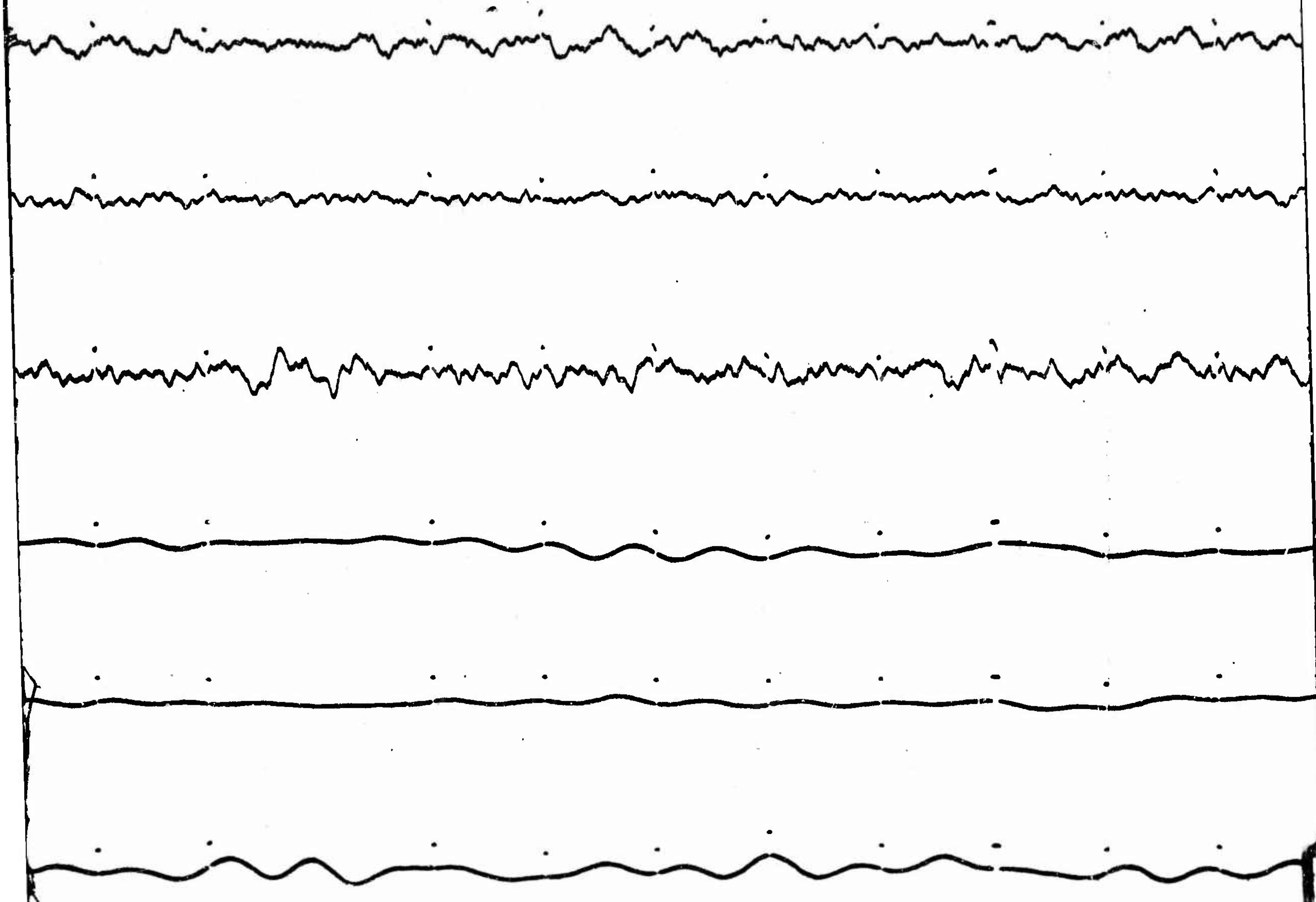

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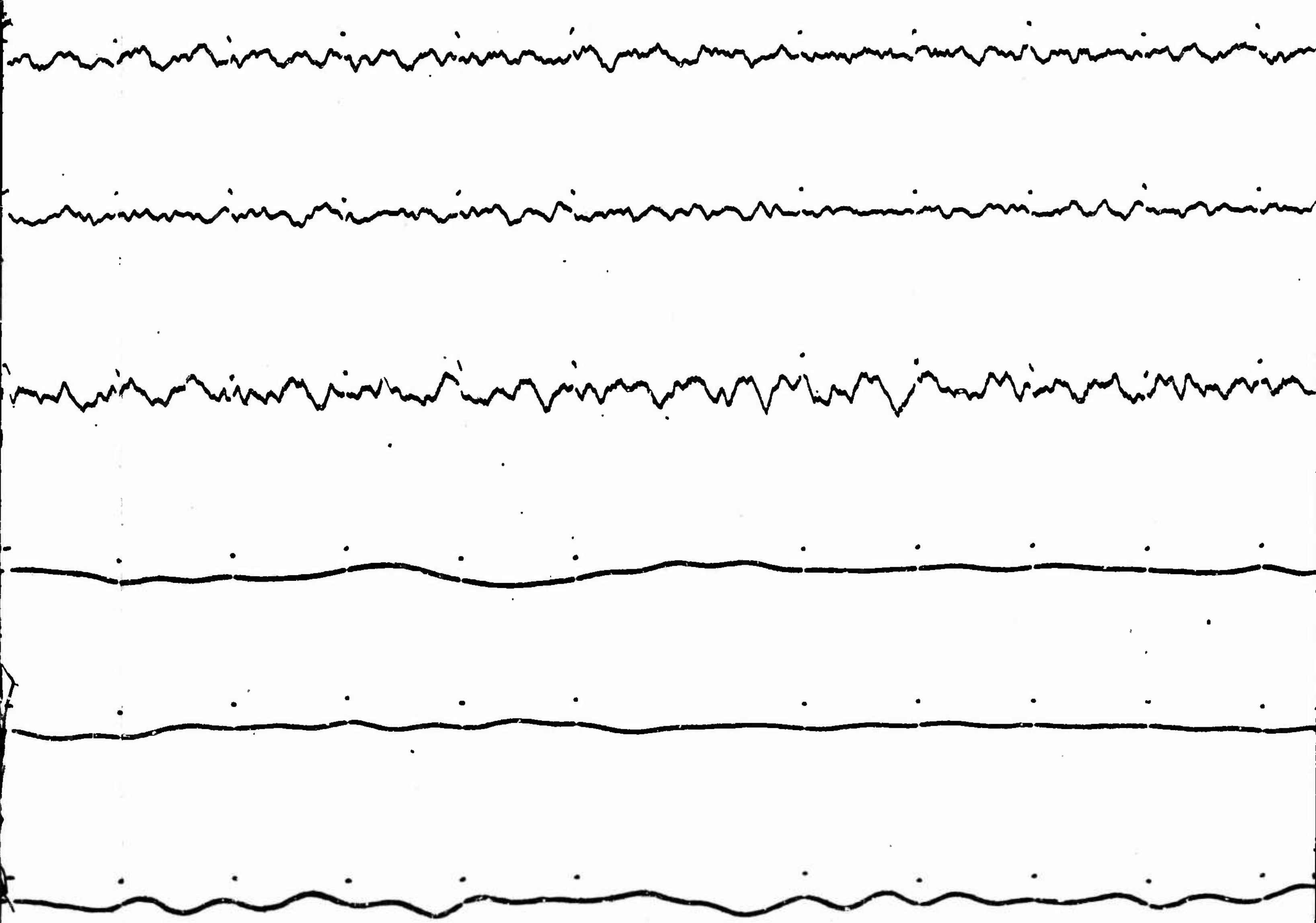

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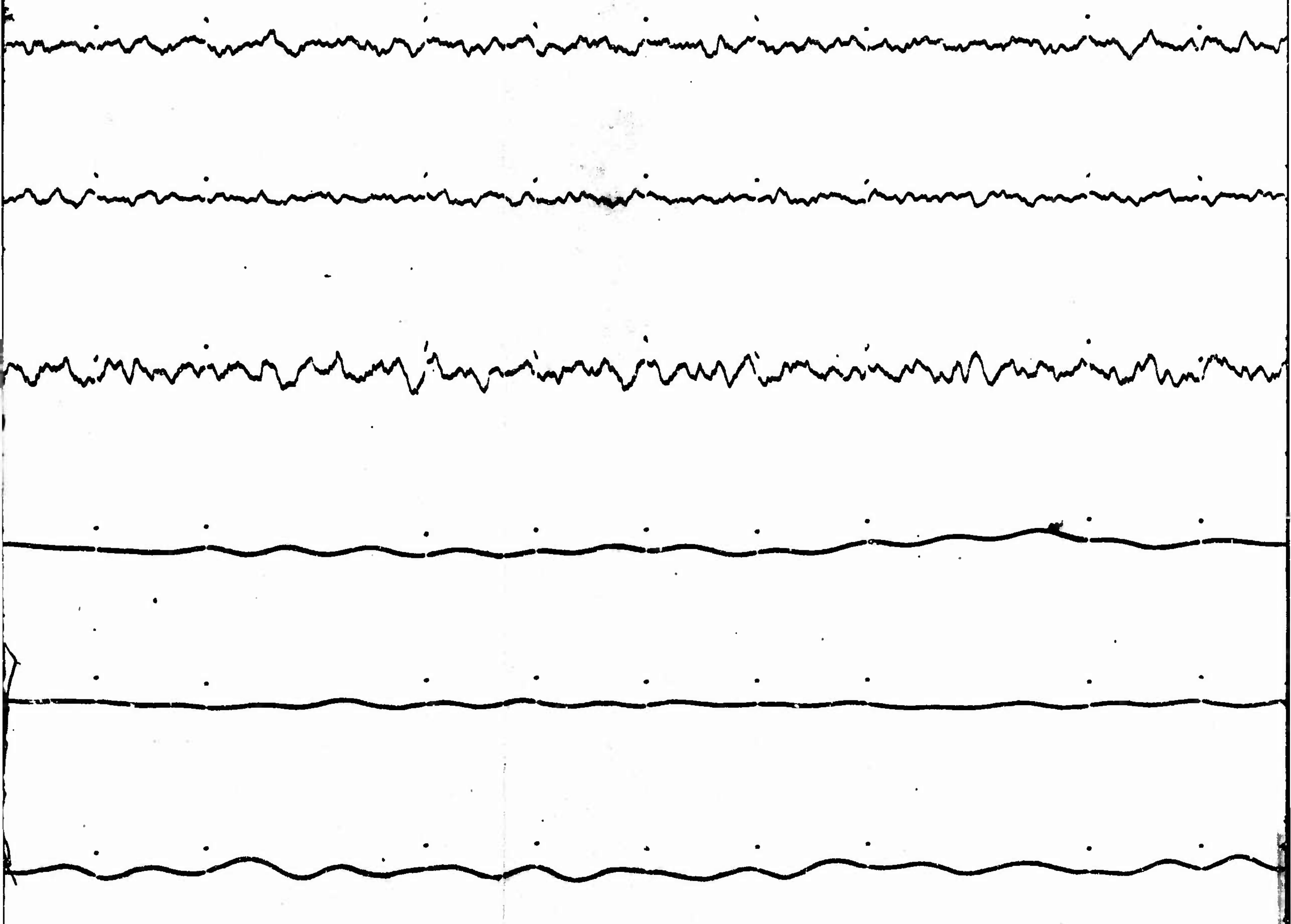

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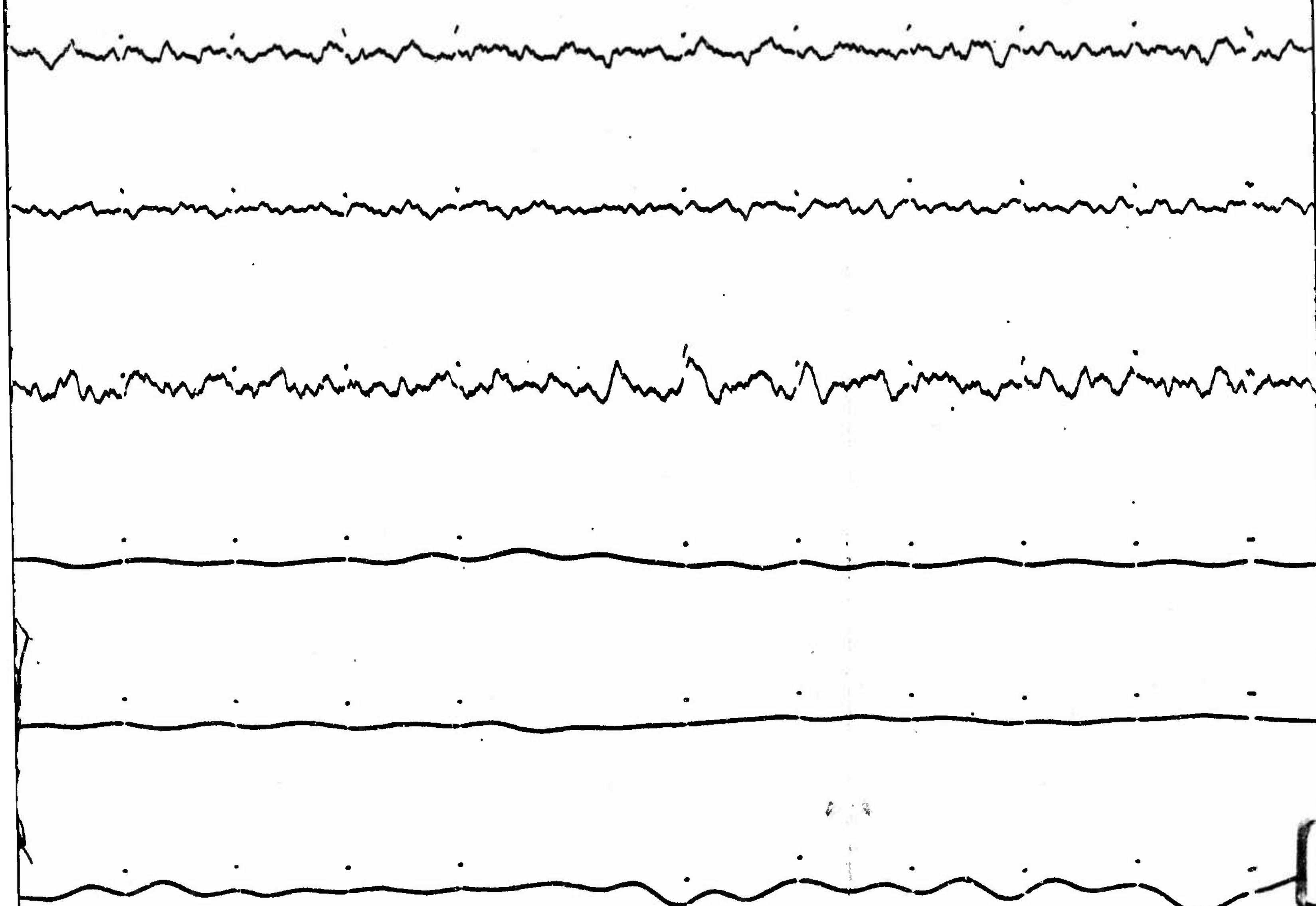

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